:ates
ent of
re

United States
Department of
Interior

Bureau of
Land Management

Man, Models and Management

An Overview Of The Archaeology Of The Arizona Strip And The Management Of Its Cultural Resources

MAN, MODELS AND MANAGEMENT: AN OVERVIEW OF THE ARCHAEOLOGY OF THE ARIZONA STRIP AND THE MANAGEMENT OF ITS CULTURAL RESOURCES

Report Prepared for:

USDA Forest Service
USDI Bureau of Land Management

Contract No. 53-8371-6-0054

Jeffrey H. Altschul
Helen C. Fairley

Contributors

Phil R. Geib
Daniel D. Mareno
Martin R. Rose

Submitted by:

Statistical Research
Plateau Archaeology
Dames & Moore, Inc.

1989

Jennifer Jack (BLM): Photograph by Nancy Rhodes.

To Jennifer Jack

Whose spirit still lights the path and emboldens those who dare continue the trek.

CULTURAL RESOURCE MANAGEMENT SUMMARY

The region encompassing the land north and west of the Colorado River in the State of Arizona is the subject of this Class I cultural resources overview. This region, commonly referred to as the Arizona Strip, contains approximately 3.5 million acres, of which 2.75 million acres are administered by the Bureau of Land Management (BLM), 650,000 acres are under the jurisdiction of the USDA Forest Service, and the balance is controlled by various State and Federal agencies, Indian tribes, and private concerns. Within the Arizona Strip approximately 4000 archaeological sites have been recorded. Of these, about 1500 are found on land administered by the BLM, slightly over 700 are located on the North District of the Kaibab National Forest, about 1200 are situated north of the Colorado River within the confines of the Grand Canyon National Park, and close to 400 sites are found north of the Colorado River in the Lake Mead National Recreation Area. The rest have been recorded by various State and private institutions on non-federally controlled land.

This overview is divided into two parts. Part One consists of six chapters which provide background information on the prehistory, history, and environment of the Arizona Strip. Environmental data are brought to bear showing the strong bimodal pattern of precipitation and temperature that currently affects the region. Information gathered from four paleoclimatic indicators; tree-rings, prehistoric pollen, alluvial stratigraphies, and packrat middens, show that various climatic regimes have established themselves at different times and in different parts of the Strip during the late Quaternary Period.

Archaeological data are then brought to bear on the issues of cultural development. Little information exists on the earliest periods of human occupation, the Paleoindian and the Archaic. The succeeding Formative Period is much better represented. Over 60 percent of the recorded sites on BLM and Forest Service land date to this period. Although most information about prehistoric occupations on the Arizona Strip relates to the Formative, there is still very little known about the exact nature of culture at this time. Clearly, the societies occupying the region were greatly influenced by the developments to the east associated with the Kayenta Branch of the Anasazi culture. Topics such as the nature of outside influence, the importance of plant domesticates, and the sudden abandonment of the region around A.D. 1200 still need more study.

Part Two concerns the management of cultural resources on the Arizona Strip. This part is divided into four chapters. The discussion begins with an overview of the types and distributions of know cultural resources throughout the Arizona Strip. This presentation includes a series of graphic illustrations showing general site location for the region as well as maps specifically designed for BLM and Forest Service administered lands.

With the resources in mind, the discussion proceeds to an evaluation of the structure of the BLM and Forest Service cultural resource management (CRM) programs. Both agencies are dedicated to a balanced CRM program that includes both identifying and mitigating potential adverse impacts of development projects on significant cultural resources and the enhancement and development of cultural resources as a goal in-and-of-itself. Yet it is clear that the current CRM programs of both agencies are geared primarily towards meeting their compliance objectives. While understandable given the legal priority of compliance work, this orientation has the result of placing both programs in a reactive as opposed to and active posture vis-a-vis cultural resource management. In the long-run, such a narrow focus is not in the best interest of sound management.

The final two chapters provide a series of recommendations. At the most general level, it is suggested that both agencies adopt procedures that allow the results of compliance work to be routinely synthesized in a manner conducive to addressing the research topics outlined in Part One.

A specific approach, termed red flag modeling, is described. Two examples of the approach derived from areas of current concern for the Forest Service and BLM are presented. The document concludes with a discussion of specific actions each agency could immediately adopt to improve the efficiency and quality of their CRM programs.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

This report is the result of a combination of efforts and skills of many people over a long period of time. Besides the individuals, this project involved three separate companies spread over the state of Arizona. First, and foremost, we would like to acknowledge the efforts of the Contracting Officer's Representative (COR) of this project, Dr. John Hanson of the Kaibab National Forest. It is a long-held maxim at Statistical Research that a good COR is a delight, and a bad one makes you wish you were selling cars in Nogales. John is one of the best and we greatly appreciate all of the help he provided. We would also like to express our appreciation of Mr. Dale Fabien, the Contracting Officer, who ably administered the contract.

Personnel from the Bureau of Land Management contributed significantly to this project. We specifically acknowledge Jennifer Jack and Richard Malcolmson, Arizona Strip Area Archaeologists, and Gary Stumpf, BLM State Archaeologist for Arizona, for their valuable input throughout the course of this project. Although Jennifer's untimely death was a great loss for the archaeological profession, Her enthusiastic interest in Arizona Strip archaeology and her personal dedication to the successful completion of this project are reflected throughout the document.

While writing this overview, we benefited from the expertise of numerous individuals. We are especially grateful to Richard Ambler, Janet Balsom, Teri Cleeland, Marietta Davenport, William Davis, Robert Euler, Catherine Fowler, Larry Lesko, Margaret Lyneis, Douglas McFadden, Robert Manners, R.G. Matson, Richard Thompson, Deborah Westfall, and Greg Woodall for sharing their knowledge and opinions with us.

The library and collections at the Museum of Northern Arizona (MNA) were consulted on numerous occasions throughout the course of this project. Special thanks are due to Dorothy House, MNA librarian, and her able assistants, for tracking down many of the references used in this overview. Don Weaver, former MNA Curator of Anthropology, kindly gave us permission to reproduce unpublished site plans and photographs from MNA's collection.

This project involved a considerable amount of computer manipulation. In transferring data from AZSITE we were aided by Kenneth Kvamme of the Arizona State Museum and Dan Martin of the Bureau of Land Management. The Forest Service data were provided by Landon Smith of the Forest Service.

Data manipulations for this project were conducted at Dames and Moore, Inc. in Phoenix, Arizona. Dames and Moore's involvement in this project was largely due to A.E. (Gene) Rogge's interest in the Arizona Strip. Gene not only provided valuable insight into the modeling effort but also server as peer reviewer. Dan Mareno wrote all of the software necessary to merge the various databases, conducted all analyses using the GIMS geographic information system, and contributed Appendix 3.

In addition to the involvement of Dames and Moore, we were also fortunate to obtain the services of Martin Rose of the Laboratory of Tree-Ring Research at the University of Arizona. Martin compiled and synthesized all the environmental data presented in Chapter 2.

The bulk of the data compilation and synthesis was conducted by Plateau Archaeology personnel in Flagstaff, Arizona. Marietta Davenport coded the site data for computer entry. Laura Allen conducted the initial historical research and wrote a preliminary draft on Arizona Strip history which provided the foundation for Chapter 5. Phil Geib administered Plateau's effort, commented on parts of the draft and co-authored Chapter 7.

Production of the report has been greatly aided by the efforts of the Statistical Research staff. Deborah Altschul ably managed the project. David Gregory and Steven Shelley critically reviewed various portions of the manuscript, and Linda Gregonis technically edited the entire document. Finally, all drafting was conducted by Ms. Kathe Kubish. Matthew Sterner produced the final volume.

The photographs adorning the front cover are courtesy of the Museum of Northern Arizona. The photograph of Ms. Jennifer Jack is courtesy of Nancy Rhodes from The Daily Spectrum, St. George, Utah.

To all of the above individuals and to other contributors whose names have not been specifically mentioned, thank you.

Jeffrey H. Altschul
Helen C. Fairley

CHAPTER 1

INTRODUCTION

The Arizona Strip refers to the portion of the State of Arizona that lies north and west of the Colorado River (Figure 1). This region encompasses approximately 3.5 million acres. Of this total, 2.75 million acres are administered by the Bureau of Land Management (BLM) Arizona Strip District, which is administratively divided into the Shivwits and Vermillion Resource Areas, 650,000 acres are under the control of the Kaibab National Forest, and the remainder are administered or owned by various state and federal agencies, Indian tribes, and private concerns. This document contains an overview of the prehistory and history of the Arizona Strip. It also deals with the sites that make up this record and ultimately the management of these resources.

This project was funded jointly by the Arizona State Office of the BLM and Region 3 of the Forest Service. It is one of nine Class I cultural resource overviews that will eventually cover the entire state of Arizona (Figure 2). To date four such overviews have been completed and published; these were for the Little Colorado (Plog 1981), Southwest Arizona (McGuire and Schiffer 1982), Southeast Arizona (Bronitsky and Merritt 1986), and West Central Arizona (Stone 1986, 1987) areas. There are strengths and weaknesses to each of these overviews. All try to be a comprehensive synthesis of previous work in the area; a task which, if accomplished, is a monumental achievement. Given the effort necessary to compile and integrate the archaeological data, it is not surprising that these documents are heavily weighted in this direction.

In addition to synthesizing the archaeological record, overviews should provide guidance to future management of the resources. All four previous overviews in this series attempt to do so but in our opinion fall short of this goal. The shortcomings of these overviews are not so much a result of lack of interest or ability as they are the agencies' inability to use the recommendations in a practical manner. As originally conceived, a major function of a Class I Overview was to provide a basis for designing subsequent field surveys. These surveys were a direct outgrowth of Executive Order 11593, which mandated all Federal agencies to inventory land under their administration for cultural resources. For agencies such as the BLM and the Forest Service, which administer millions of acres, complete inventory was simply not practical. Consequently, these agencies adopted a phased approach, consisting of an overview (Class I) to be followed by sample surveys (Class II), leading finally to intensive surveys (Class III) wherever needed.

Following this proscription, the management sections of the overviews conducted to date have been oriented towards inventory recommendations. Thus, we find McGuire and Schiffer (1982) and Stone (1986) writing detailed sections on such topics as survey strategy and sampling. Although interesting, these sections have not been very useful in guiding Federal cultural resource management (CRM) programs. The plain truth is that the agencies do not have the resources to conduct these large-scale inventories; they do not have them now and it does not appear that they will have them in the foreseeable future.

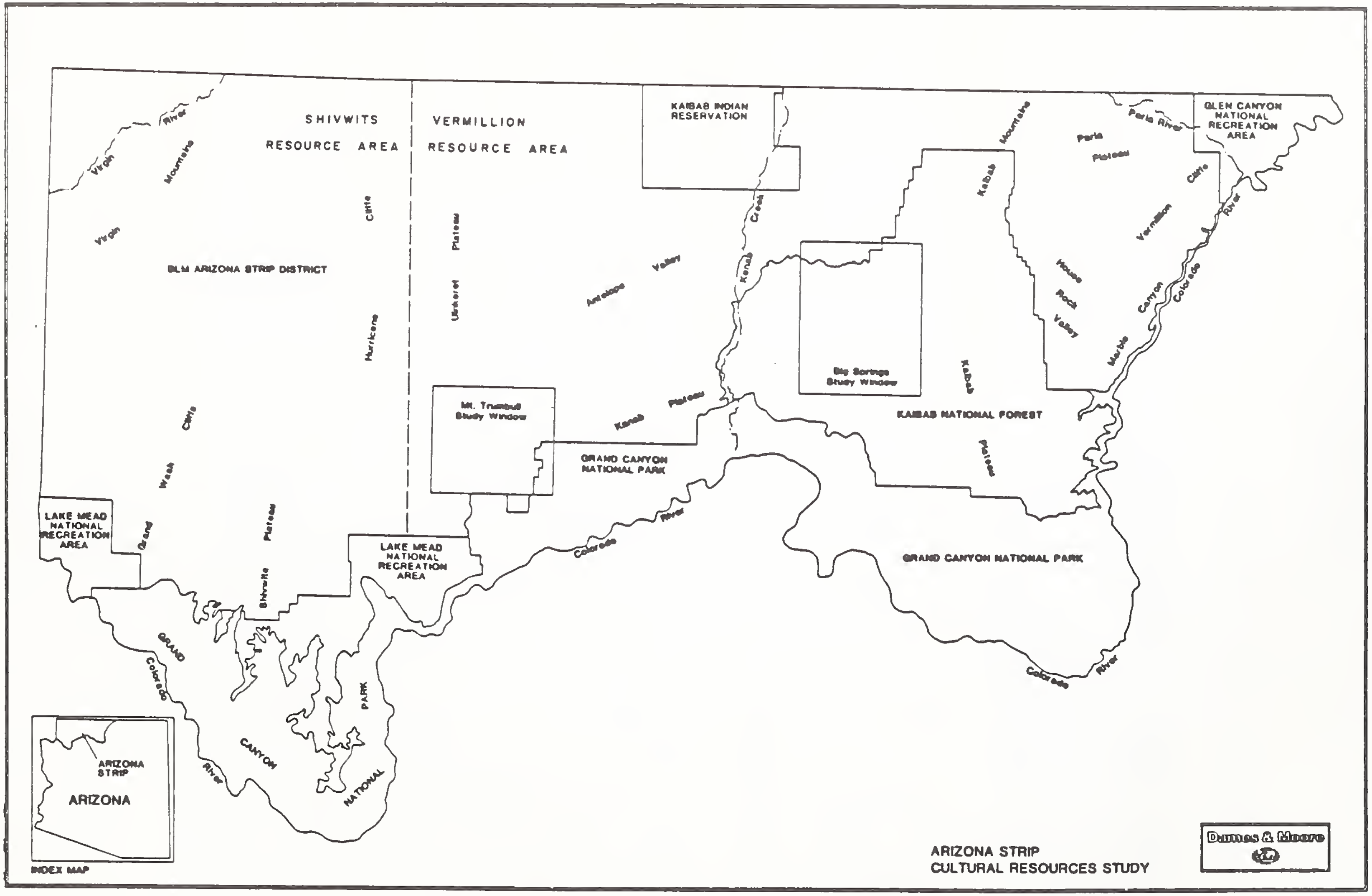


Figure 1. Arizona Strip.

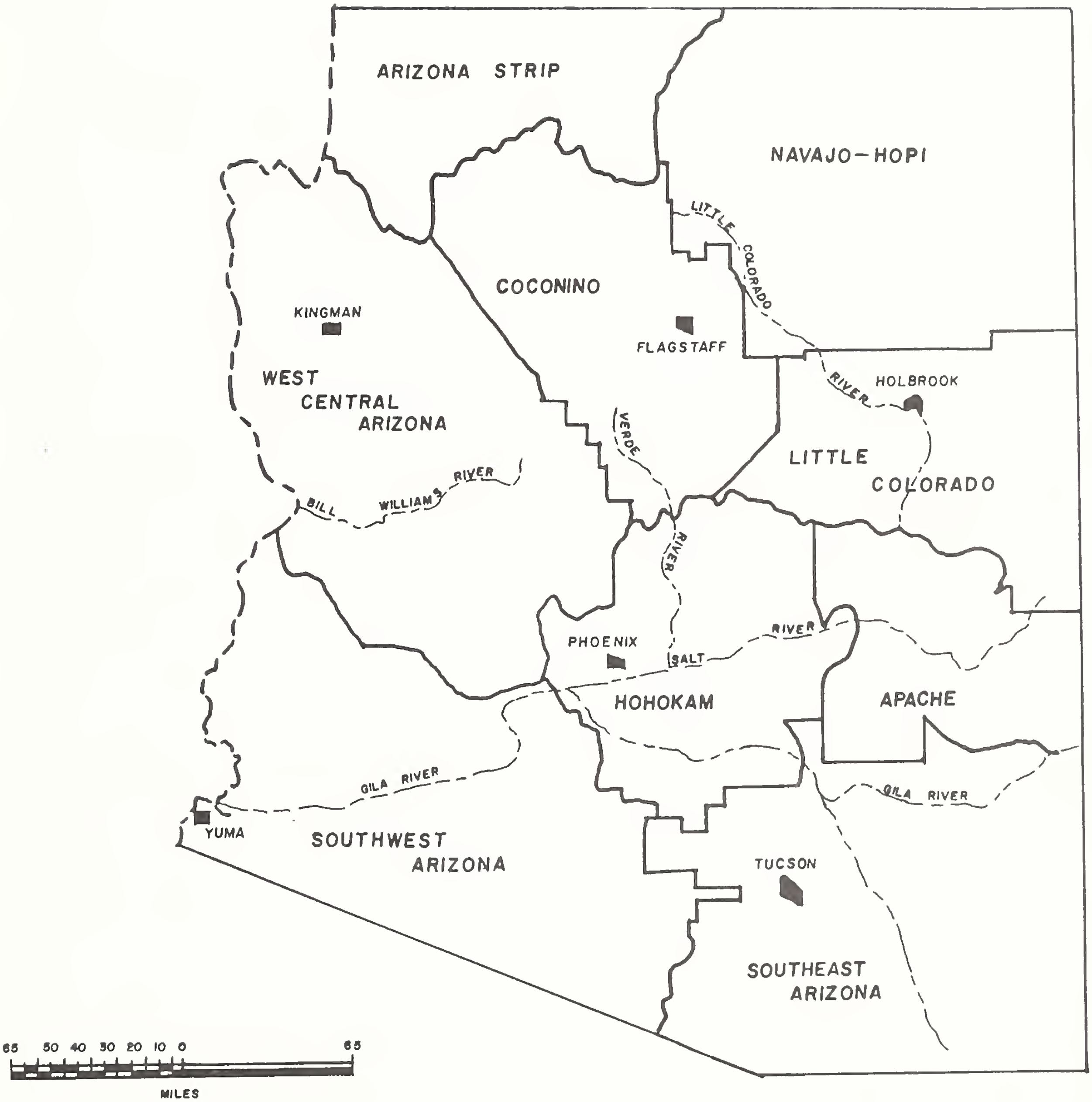


Figure 2. Divisions of Arizona for Class I Overviews. Courtesy of the Bureau of Land Management.

The CRM programs of the BLM and the Forest Service on the Arizona Strip, as with virtually all Federal agency programs, are for the most part compliance-driven. Archaeological and historical work is conducted as a consequence of a particular proposal to develop some other resource. The amount of current or planned research on the Strip by federal agencies, state universities, or private institutions is relatively small. The needs of the Arizona Strip BLM and Forest Service CRM programs are not so much in the design of Class II surveys that are unlikely to occur as they are in restructuring the programs so that instead of focusing primarily on compliance efforts, the results generated are part of the mainstream attempt to understand our cultural heritage. This restructuring we took as the basic charge of our work.

This overview had two basic goals. The first was to compile, integrate, and synthesize much of the archaeological and historical data available for the Arizona Strip. In this regard, our objective does not differ from previous overviews. Our second goal was to offer recommendations. It is in this objective that this overview follows a different tack than its predecessors. There is little discussion herein of inventory surveys or how they should be designed. Instead the focus is on the conduct of CRM as it is pursued today on the Arizona Strip. Recommendations are offered at several levels, from the general orientation and attitude of the agencies toward CRM to actual field techniques. In all cases we focused on actions that can be taken today. Such an approach may seem shortsighted. It is our belief, however, that an overview, indeed the entire overview process, must be dynamic in nature. It is hoped that the research goals and topics outlined here will be grossly outdated within a decade. In a similar vein, we sincerely hope that management issues that need attention in the year 2000 are not the same ones being discussed today.

REPORT ORGANIZATION

This report is divided into two parts. Part One, which consists of Chapters 2 through 6, is a synthetic discussion of the issues pertaining to the prehistory and history of the Arizona Strip. Chapter 2 outlines past and present environments of the region. Chapter 3 is a critical review of previous archaeological research, and Chapter 4 outlines the prehistoric culture history. Chapter 5 presents a historic narrative about the Arizona Strip. Part One closes with Chapter 6, which outlines current prehistoric research topics and data gaps.

Part Two of the overview is devoted to the management of cultural resources on the Arizona Strip. Organization and content of the available databases are discussed in Chapter 7. The general structure of the current CRM programs of the BLM and the Forest Service are outlined and critiqued in Chapter 8. Chapter 9 presents an approach to remedy one of the major deficiencies of both CRM programs discussed in Chapter 8. This deficiency concerns the current inability to readily synthesize the results of compliance work conducted on the Strip. The remedy is a form of spatial modeling that can easily be incorporated into everyday management procedures. The overview closes with Chapter 10, which discusses various threats to archaeological and historic resources, the nature of use categories as employed by the BLM and the Forest Service, and specific management recommendations for each agency.

PART I

ENVIRONMENT AND CULTURE ON THE ARIZONA STRIP

CHAPTER 2

PRESENT AND PAST ENVIRONMENTAL CONDITIONS

Martin R. Rose

This chapter is divided into three parts. The first part presents background information on the modern environment of the Arizona Strip -- the physiography, climate, and vegetation. The second part focuses on past conditions, and the third portion presents a brief discussion of the interplay between environmental conditions on the Arizona Strip and potential human adaptations.

The first part of the chapter contains a brief description of the physiography of the region. The atmospheric controls of the present climate of the northern Arizona region are presented next, along with a description of the monthly variability in temperature and precipitation and how it relates to elevational, latitudinal, and longitudinal gradients. A discussion on the vegetation of the region then follows. The first part of the chapter closes with a brief statement about the salient environmental conditions of the Arizona Strip.

MODERN ENVIRONMENT

Physiography

The basic physiography of the study area is briefly described because of its importance as one of the ultimate determinants of such environmental patterns as climate, hydrology, soils, and vegetation. The Arizona Strip is best described as a series of plateaus (see Figure 1). The Paria Plateau is located in the extreme northeastern part of the area, northwest of the Colorado River. West and southwest of the Paria Plateau, the Kaibab Plateau runs from the Utah border to the Colorado River. The central part of the study area is occupied by the Kanab Plateau, which reaches from southern Utah to the Colorado River. The Vermilion Cliffs are present on the northeastern part of the Kanab Plateau and the Houserock Valley, and the Hurricane Cliffs form the plateau's western boundary from Utah to north of the Colorado. The Hurricane Cliffs also form the eastern boundary of the Shivwits Plateau, which also lies east of the Grand Wash Cliffs. West of the Grand Wash Cliffs lies the Basin and Range province.

The southern boundary of the Arizona Strip is defined by the Colorado River, one of the few sources of water in the region, but also the most inaccessible. Other permanent sources of water in the Strip include the Virgin River in the extreme northwest, Kanab Creek, which bisects the region from north to south, and the Paria River in the extreme northeast.

Outside of the sources mentioned above, water availability is limited to springs and seeps. Springs producing less than approximately 7.5 liters per minute are present in some areas on the Arizona Strip, but they are not plentiful. Other areas have no permanent springs, but do have seeps after wet seasons.

The water quality of the springs and seeps varies, with some of the best in the Virgin Mountains and at locations in the Navajo sandstone formation. Total dissolved solid (TDS) content varies from 200 to

800 mg./liter. The U.S. Public Health Service (1962) has recommended that water for drinking purposes should contain no more than 500 mg./liter of dissolved solids. Water that contains a larger dissolved-solids concentration is used, however, if better water is not available. Additional limitations are imposed on the concentrations of specific chemical constituents, such as iron, sulfate, chloride, and nitrate. Springs and seeps in the Moenkopi and Kaibab formations generally have higher TDS values, ranging from 1,200 to 2,400 mg./liter, rendering them unsuitable for human consumption. Locations with permanent springs would seem to have a higher probability of evidence of prehistoric use than areas with seeps, which might have been exploited on a more intermittent basis following periods of above average precipitation or cooler temperatures.

Most of the major canyons draining the western side of the Virgin Mountains including Hancock, Boulder, Frehner, and Hedricks canyons, have springs with flows of less than 7.5 liters/minute. The TDS of these waters, commonly less than 600 mg./liter, renders them relatively good from a chemical standpoint for human consumption (Bureau of Land Management 1980). Sullivans Canyon, running into the Virgin River from the north, has ephemeral flow only during periods of heavy rainfall. It has few springs, but those that are present range in production from a seep to a maximum of about 30 liters/minute, with a mineral content ranging from about 100 to 1000 mg./liter. Values in the upper part of the range are unfit for human consumption.

Surface runoff from the Vermilion Cliffs region is entirely ephemeral, originating in channels along the walls of the cliffs. About halfway up the Vermilion Cliffs, several springs of excellent quality flow from the base of the Navajo sandstone. These springs are generally small, but the combined production of some drainages may be as high as 95 liters/minute.

The Paria River, the primary drainage for Paria Canyon, is intermittent north of the Arizona-Utah state line. Its perennial flow south of the state line is maintained by springs discharging from the Navajo sandstone. These springs release five to seven cubic feet/second of water of excellent chemical quality, though the flow of the river during much of the year is turbid, having a substantial amount of suspended sediment (Bureau of Land Management 1980).

Any consideration of site locations on the Strip away from accessible portions of the major riverine environments mentioned above must consider the potential importance of springs. The quality of the water from these springs, in terms of human consumption and agriculture, is an important variable to consider. In addition to the 500 mg./liter human consumption guideline mentioned above, the suitability of water for agriculture should be considered. For example, possible dangers from excessive concentrations of sodium include the breakdown of soil structure and nutritional disturbance in crops. Seeps may have also been important secondary sources of water during periods that were cooler and moister. These periods, in a general sense, can be determined from the dendroclimatic summary presented later in this chapter.

Modern Climate

This discussion begins with a description of the general northern hemisphere circulation mechanisms affecting both the overall climate of the southwestern United States and local variations in that climate. Descriptions of relevant monthly, seasonal, and annual changes in temperature and precipitation can then be placed in proper perspective.

To understand the physical environment to which past human populations on the Arizona Strip were adapted, it is necessary to consider not only present climatic conditions but also how these conditions have changed over the past 12,000 years. Climate is the ultimate determinant of water availability and the thermal environment, which interact to determine the actual amount of energy that can be captured by plants at any one time and place. Because climate is a major determinant of both soils and vegetation, particular climatic conditions correspond closely with different types of natural biological communities. These communities provide the environmental matrix in which past human populations operated.

Seasonalization of Climate Data

Horn et al. (1957) present an objective precipitation climatology of the United States, in which they distinguish between rainfall types and rainfall regimes. The term regime is usually associated with a persistent or frequently repeated situation. For example, one area may receive nearly equivalent amounts of precipitation in winter and summer, while another location may only receive a significant amount in summer. These two areas have different rainfall types but similar summer regimes.

In their investigations, Horn et al. (1957) mapped relative intermonthly rainfall changes to portray regimes. The analysis shows that Arizona has a bimodal precipitation type with winter and summer regimes, while the area to the east in New Mexico is more unimodal with only the summer dominant regime similar to Arizona. Sellers and Hill (1974:8) present graphs of mean monthly precipitation totals for Arizona, which visually demonstrate the dominant winter-summer distribution, while the rainfall dispersion diagrams for New Mexico presented by Tuan (1973) show the summer dominant pattern. It is thus confusing to discuss Southwestern precipitation, especially that in the Colorado Plateau region, in terms of either summer or winter dominance, since one or both regimes may be present depending on the location. The importance of this point cannot be overemphasized, because its neglect in Southwestern archaeological studies over the past two decades has caused considerable misunderstanding about the nature of past climatic variability, not to mention human response to that variability.

Mitchell (1969; 1976:920-927) has examined the problem of local climatic variation in the western United States from a temperature perspective. A monthly series of equivalent potential temperature maps reveals two basic patterns during the year. A winter pattern is present from November to March and a summer pattern from June to September. Transitions between winter and summer occur in April, May, and, to some extent, June. The transition from summer to winter occurs in October and to some extent September.

Two equivalent potential temperature gradients emerge during summer. One lies far to the west in California, Oregon, and the northwestern states, while the other gradient, in the Southwest, is referred to as the monsoon boundary. It runs from extreme western Arizona, northeast through the Four Corners area and into the Plains. The monsoon boundary is the surface boundary between the warm, moist tongue of air lying across the southwestern United States and the warm, dry air overlying most of the interior western United States during the summer. Therefore, the Arizona Strip lies in a region where the summer monsoon begins to lose its strength. The important aspect of the winter pattern that Mitchell defines is the general zone of high pressure over southern Nevada, which blocks Pacific air masses. This high breaks down from time to time to permit the flow of air from the Pacific.

Any attempt to summarize the climate of the Arizona Strip region is hampered by a lack of data -- there simply are not many lengthy records giving a homogeneous spatial coverage. To obtain a more local view of changes in mean monthly temperature and total monthly precipitation with elevation, latitude, and longitude, meteorological summaries of nineteen stations in and immediately adjacent to the Arizona Strip were analyzed (Table 1). Additional nearby stations in Utah should be considered in any further study of general climate of the strip region. Ideally, all of the average climatological values should be based on the same observation period at each station, although this is difficult to achieve for the Arizona Strip area because stations have operated for different lengths of time in different areas. For this reason, and because the analysis is largely exploratory, the mean temperature and precipitation values are taken from summaries in Arizona Climate, by Sellers et al. (1985). The analysis documents the potential feasibility of a more detailed climatological investigation.

The objective of the analysis was to test whether there are any statistically significant correlations (alpha = 0.05) between maximum, minimum, and average monthly temperatures, total monthly precipitation, and latitude, longitude, or elevation. If significant relationships between the meteorological variables and changes over space can be defined, they can then be used to obtain a modern climatic description for any area in which an archaeologist is interested. This then enables different locations to be compared on objective and reasonably well defined grounds. When considering the long term perspective on relative climatic variability offered by tree-ring index series, discussed later in this chapter, it facilitates defining which areas may have been "better" or "worse" in climatic terms.

Table 1. Locations of Climatological Stations. Latitude and longitude are given in degrees and decimal equivalents of minutes. Elevation is in feet.

Station	Period of Record	Lat.	Long.	Elev.
Beaver Dam	08/56-12/82	3690	11393	1835
Pierce Ferry 17	06/63-12/82	3588	11408	3860
Truxton Canyon	07/48-03/80	3538	11367	3820
Peach Springs	07/48-11/82	3553	11342	4830
Mount Trumbull	10/19-12/77	3642	11333	5560
Tuweep	07/48-12/82	3628	11307	4775
Colorado City	07/63-12/82	3700	11298	5010
Seligman	12/04-12/82	3532	11288	5219
Pipe Springs NM	06/63-12/82	3687	11273	4920
Fredonia	07/48-10/85	3695	11253	4675
Jacob Lake	07/50-12/82	3672	11222	7920
Bright Angel RS	07/48-12/82	3620	11207	8400
Grand Canyon	08/57-12/82	3605	11212	6970
Williams	07/02-12/82	3625	11218	6750
Fort Valley	01/09-12/82	3527	11173	7347
Cameron 1 NNE	05/62-12/82	3588	11140	4165
Tuba City	01/00-12/75	3613	11125	4936
Coppermine TP	07/48-12/76	3663	11142	6380
Lees Ferry	04/16-12/82	3687	11158	3141

Source. Sellers et al. 1985

Winter. The continental mass of western North America cools faster than the Pacific Ocean during the winter. High pressure develops over the interior of northern North America because of persistent radiational cooling, and semipermanent lows are present over the oceans.

Large-scale storms embedded in the prevailing westerlies normally follow a northern path around the semipermanent subtropical high pressure ridge off the west coast, entering the continent in the northern Oregon/Washington area. They usually move eastward, passing south of a low pressure trough in the Hudson Bay area. The Southwest seldom has more than cloudy weather under these conditions.

To get much winter precipitation in the Southwest, including the Arizona Strip, there must be a westward displacement of the high pressure ridge in the Pacific and formation of a semipermanent low pressure trough over the western United States. Under such conditions, storms then follow the prevailing southerly flow of fast moving air currents along the west coast before entering the continent, often as far south as San Francisco. Once this flow pattern is established, it tends to persist and recur. Much of the moisture is precipitated over the coastal and inland mountain ranges of California, Nevada, Arizona, and Utah.

The spatial distribution of winter precipitation is given in Figures 3, 4, 5, and 6. The significant correlations between precipitation and elevation and latitude (there are no significant correlations with longitude) are presented in Table 2, and the regression equations relating these variables are presented in Table 3. The correlations in Table 2, and later in Table 4, show the strength of the association between a meteorological variable, such as January precipitation, and another variable, in this case elevation. The correlation values range from 0 to + or - 1, with 0 indicating no association and + or - 1 indicating a perfect positive or negative relationship. In this example, a positive correlation would indicate that precipitation increases as elevation increases. Negative correlations are most common in temperature-elevation relationships, where temperature decreases with increasing elevation.

The regression equations represented in Table 3 simply allow one to predict the average precipitation from elevation for any location on the Arizona Strip. The variation of temperature and precipitation with topography has practical significance in areas where the success of crops may be threatened by late spring or early fall frosts, or where limitations of soil moisture available to a plant make it particularly susceptible to heat injury. For example, January precipitation can be predicted by taking elevation, multiplying it by 0.00037, and subtracting 0.678. November precipitation can likewise be predicted by taking elevation, multiplying it by 0.00012, and adding 0.310. Precipitation for other months can be determined according to this simple procedure. The amount of variability in a particular variable, such as January precipitation, that is explained by elevation can range from 0 to 100 percent, and it is given under the heading of r^2. In Table 3 we see that elevation accounts for 65 percent of the variation in annual precipitation.

On a regional basis, the greatest amount of precipitation is received in January (1.27 in.), with November and December receiving 0.94 and 1.25 inches, and February having 1.13 inches. About 34 percent of the total water year (from October of the previous year to September of the current year) precipitation is received during these months, with 7.3, 9.3, 8.9, and 8.1 percent of the total received in the months from November through February.

Winter precipitation does not vary significantly with latitude or longitude, but significant correlations exist with elevation (Nov. = 0.52, Dec. = 0.71, Jan. = 0.65, Feb. = 0.66). On the basis of elevation alone, from about 44 to 50 percent of the variability in monthly winter precipitation can be accounted for or statistically explained. The values of the slope coefficients in Table 3 indicate the change in amount of precipitation with change in elevation. The surface precipitation gradient (change in precipitation with elevation) is strongest in December and January (.33 and .37 inches/1,000 ft., respectively), less in February (.25), and smallest in November (.13). These gradients, as will be discussed later, are as strong or stronger than the changes in precipitation with elevation exhibited during the warmer months.

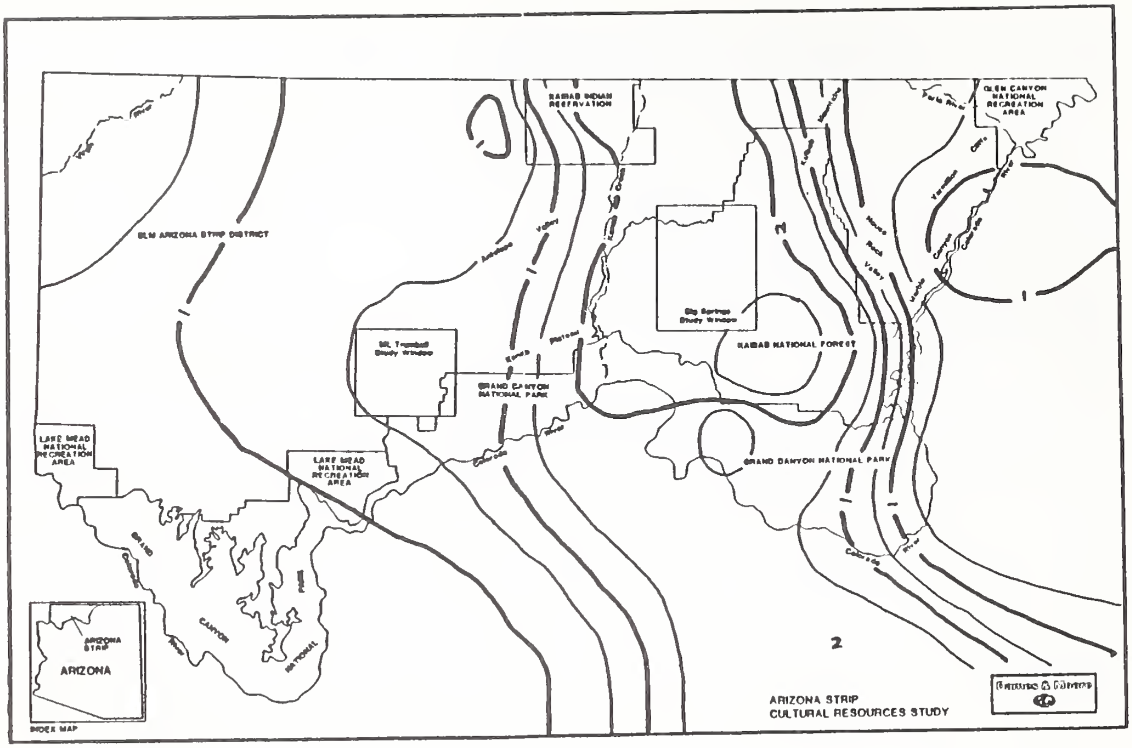


Figure 3. November Precipitation.

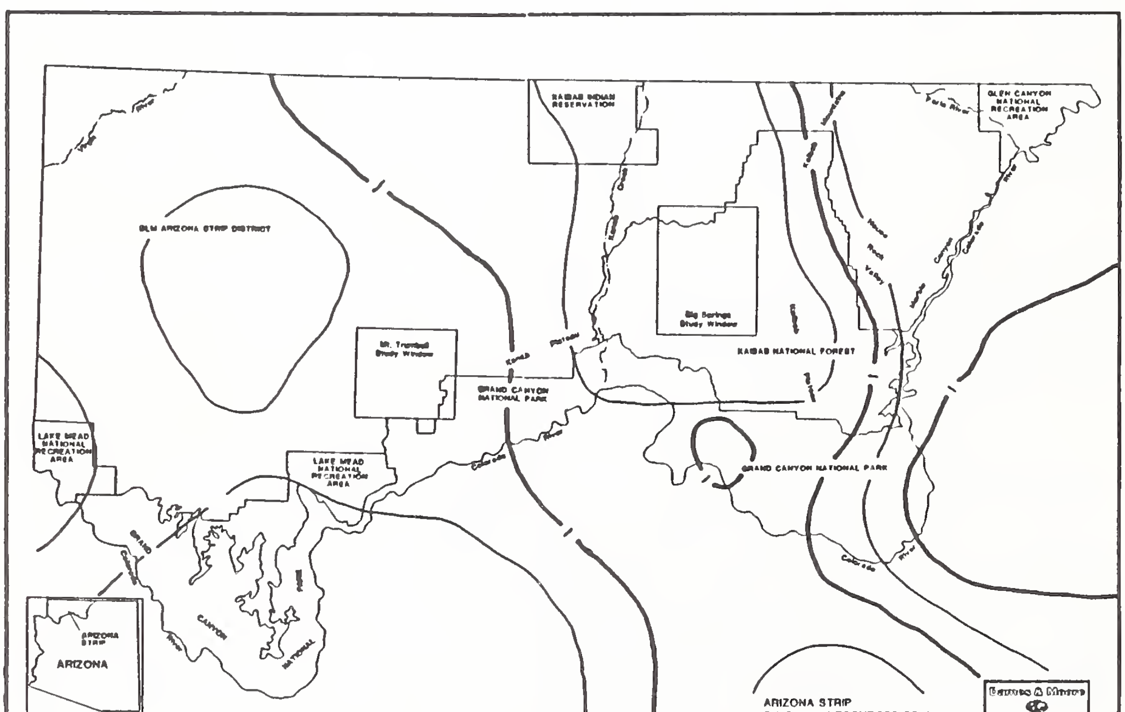


Figure 4. December Precipitation.

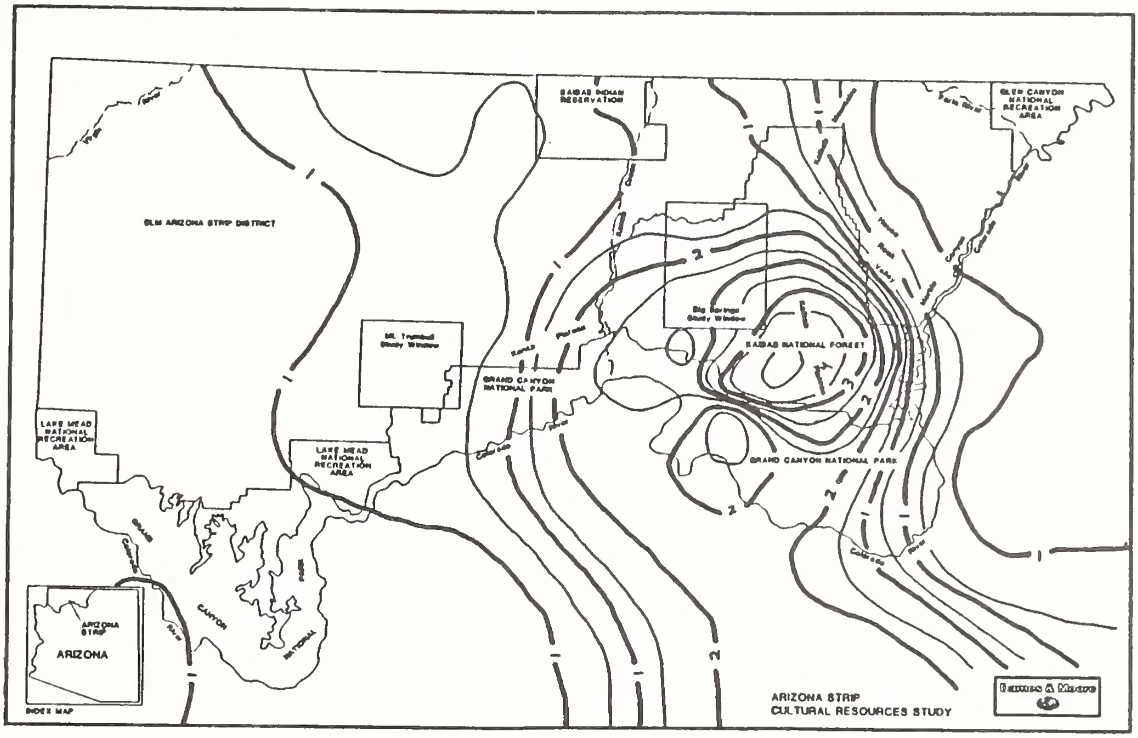


Figure 5. January Precipitation.

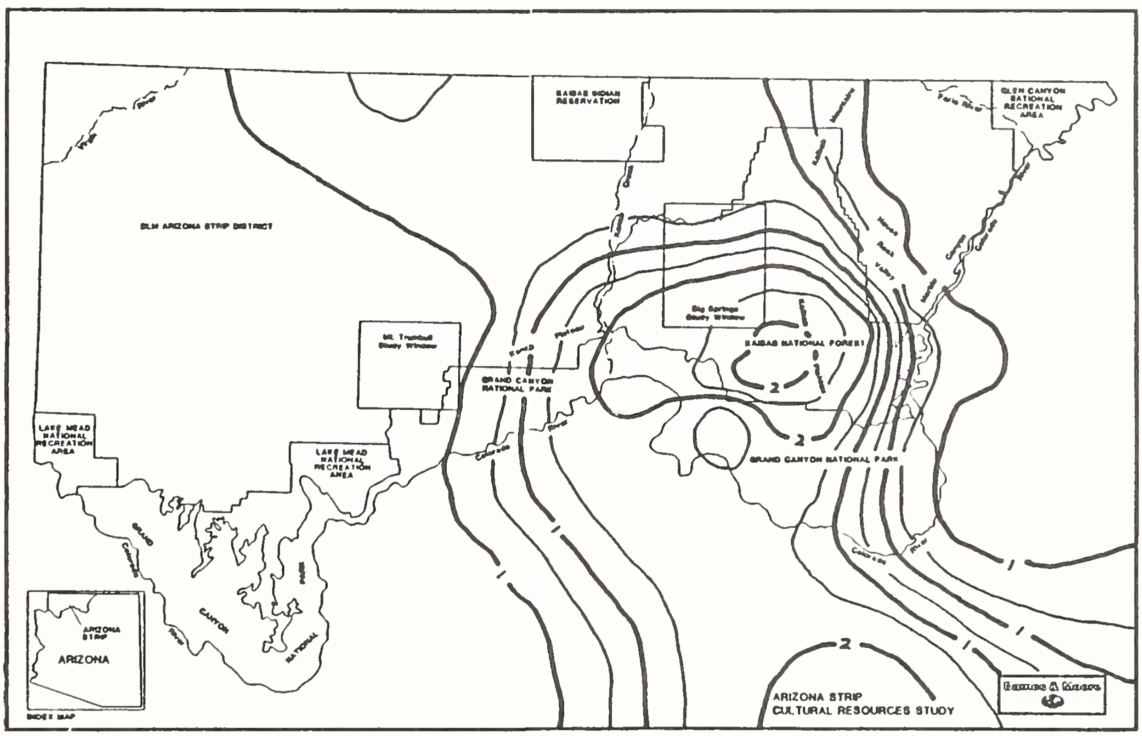


Figure 6. February Precipitation.

Table 2. Pearson Product-Moment Correlations Between Monthly Precipitation and Elevation. All are significant at the 0.05 level. Sample size = 19.

	Elevation
January	.65
February	.66
March	.60
April	.68
May	.54
June	.71
July	.72
August	.71
September	.74
October	.75
November	.52
December	.71
Annual (Oct.-Sept.)	.79

Table 3. Bivariate Regression Equations for Estimating Total Long Term Monthly Precipitation from Elevation. All of these equations explain a significant (alpha = .05) amount of variability in the dependent variable. Sample size = 19.

Month	Slope	Y-intercept	r^2	Standard Error Estimate
January	.00037	-.678	.42	.73
February	.00025	-.223	.43	.50
March	.00029	-.096	.36	.65
April	.00019	-.215	.46	.36
May	.00011	.021	.30	.30
June	.00009	-.067	.51	.15
July	.00034	-.273	.52	.58
August	.00031	.227	.50	.54
September	.00017	.140	.55	.26
October	.00017	.076	.56	.25
November	.00012	.310	.27	.33
December	.00029	-.297	.50	.49
Annual	.00282	-1.819	.65	3.55

Mean winter monthly temperatures (Figures 7, 8, 9, and 10) show an even stronger association with elevation than that shown by precipitation, and they also correlate somewhat with longitude (Table 4). The winter months are the only part of the year during which monthly temperatures vary significantly with longitude. Regression equations defining these relationships are presented in Table 5.

Highly significant correlations exist between elevation and monthly minimums, maximums, and mean temperatures during the winter months. The strongest correlations are generally for monthly maximum temperature, followed by monthly mean and monthly minimum temperatures. This indicates that monthly temperatures can be reliably estimated for most locations in the Arizona Strip region. Elevation alone accounts for most of the temperature variation. Table 5 indicates that the greatest change of temperature with elevation occurs at the beginning and end of the winter season, in November and February. These beginning and ending months are also the warmest, with a mean regional temperature of 43°F in November and 38°F in February. December and January are the coolest months with mean temperatures of 35°F and 34°F respectively.

When longitude is included as an additional independent variable in the prediction equations (Table 5) the amount of temperature variance explained increases even further. The correlations between temperature and longitude (Table 4) indicate that the effect of longitude is most pronounced in December and January and less well defined in November and February. The correlations indicate that the western end of the Arizona Strip has higher temperatures than the eastern part. This partially, but not totally, is a reflection of the elevational differences between the eastern and western parts of the area.

Spring. A general spring storm pattern in this area is lacking. The amount of annual precipitation falling in the spring months decreases from about 5.8 percent in March to 3.2 percent in June, with 5.9 and 4.5 percent in April and May. On a regional basis, the mean values are 1.4, 0.80, 0.62 and 0.40 inches. The moisture that is received (Figures 11, 12, 13, and 14) is significantly correlated with elevation (Table 2), more so in April (.68) and June (.71) than in March (.60) and May (.54). The precipitation in May and June, as a percentage of the annual total, is also weakly correlated with latitude (.62 and .57, respectively), indicating its somewhat greater importance as part of the annual total in the northern part of the Arizona Strip.

The surface precipitation gradient decreases from March through June (March = 0.29 in./1,000 ft., April = 0.19, May = 0.11, June = 0.09). To some extent, this is probably due to the decreasing amounts of precipitation available as the season progresses. That is, there is not much precipitation anywhere in the region at this time, so all of the stations throughout the complete elevational range receive about the same amount and elevation does not appear to be an important factor. On a regional average, March receives 1.41 in. of precipitation, April receives 0.80 in., the May value is 0.62 in., and June precipitation is 0.40 in.

Contour maps showing the spatial distribution of mean monthly spring temperatures are presented in Figures 15, 16, 17, and 18. The average regional spring temperatures are 43, 51, 59, and 69°F, respectively, for the months from March to June. Minimum and maximum monthly temperatures also show steady increases through the season. No significant associations are present between latitude and longitude and any of the mean monthly temperatures, or minimum or maximum temperatures. The patterns represented reflect the dominating influence of elevation, as shown by the high correlations (Table 4) between elevation and minimum, maximum, and mean monthly temperature. The values in Table 5 indicate that moisture in the air decreases as temperatures become colder (since cold air cannot hold as much moisture as warm air). The surface temperature gradients for mean monthly temperatures increase in a progressive manner from 3.65 and 3.64°F/1,000 ft. in March and April, respectively, to 3.95 and 4.15°F/1,000 ft. in June.

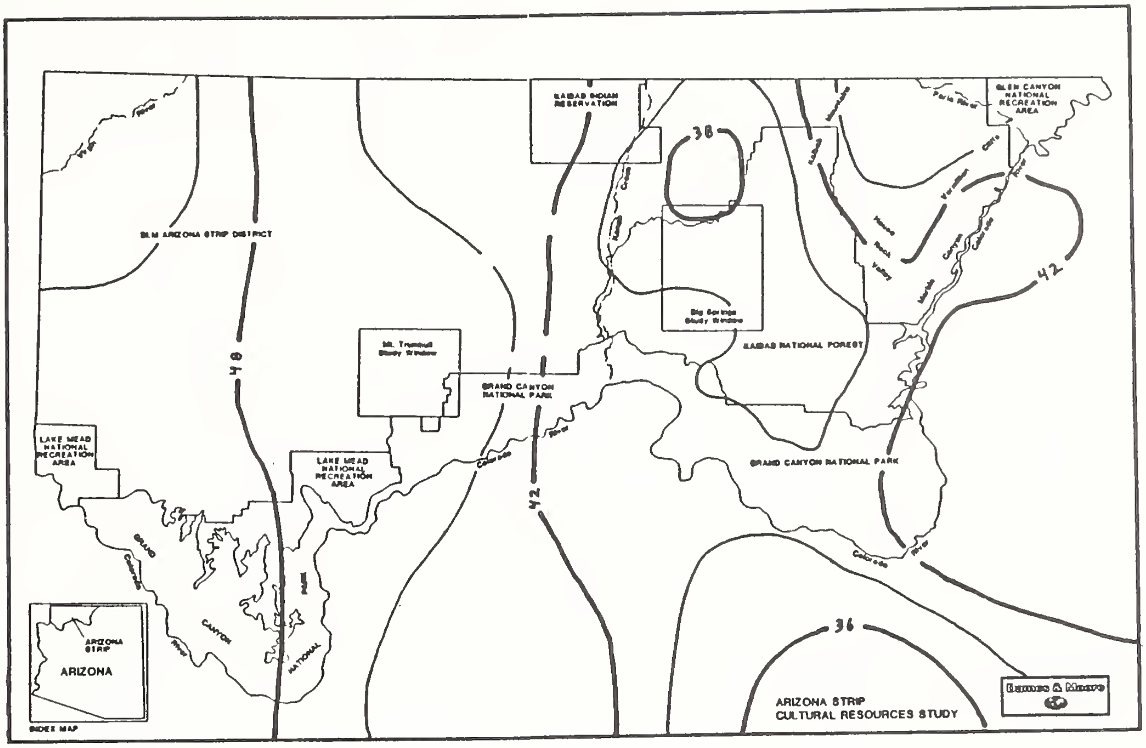


Figure 7. November Temperature.

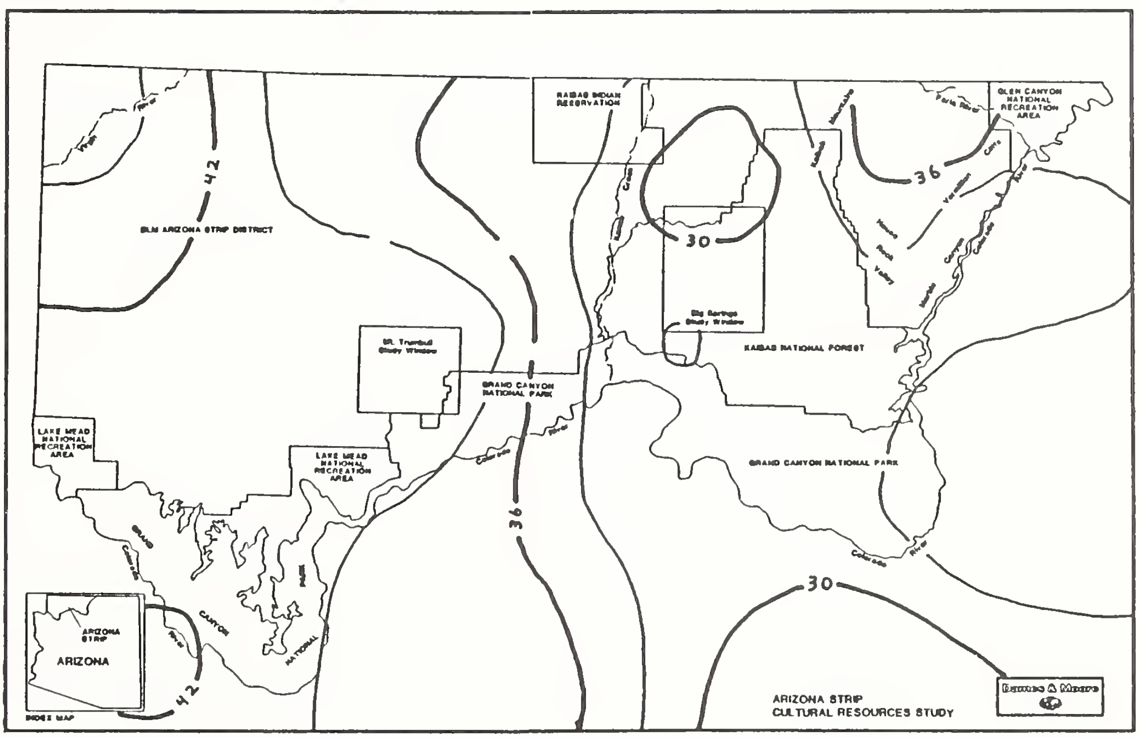


Figure 8. December Temperature.

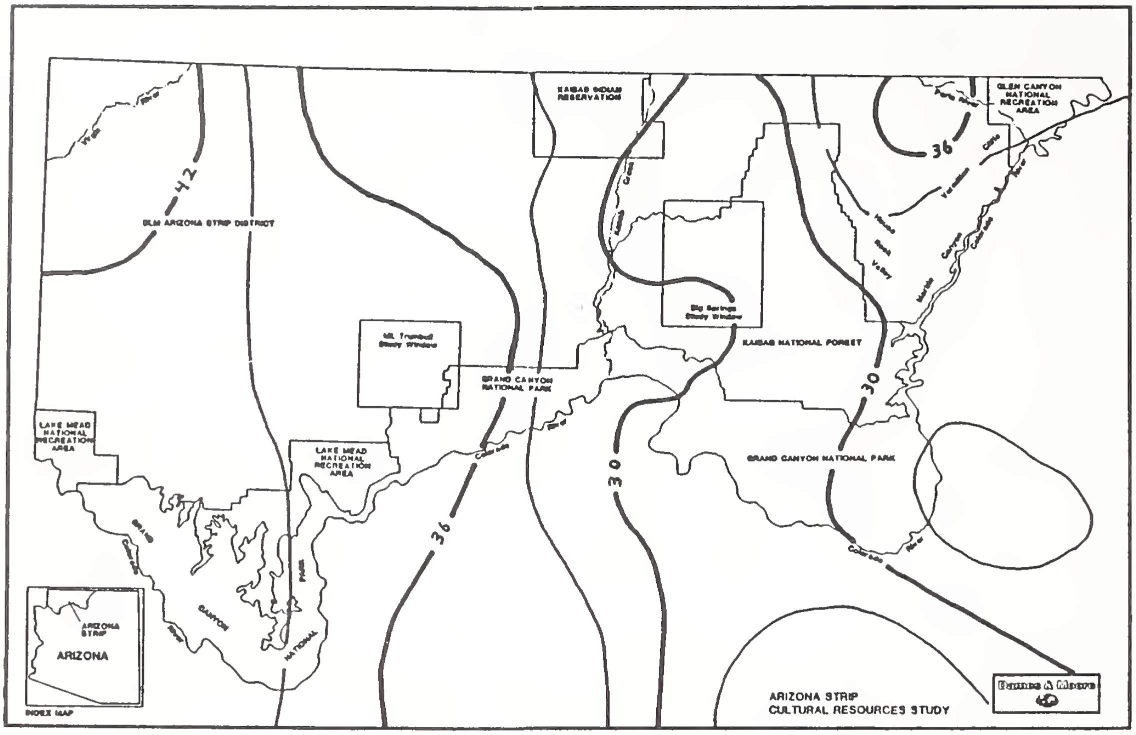


Figure 9. January Temperature.

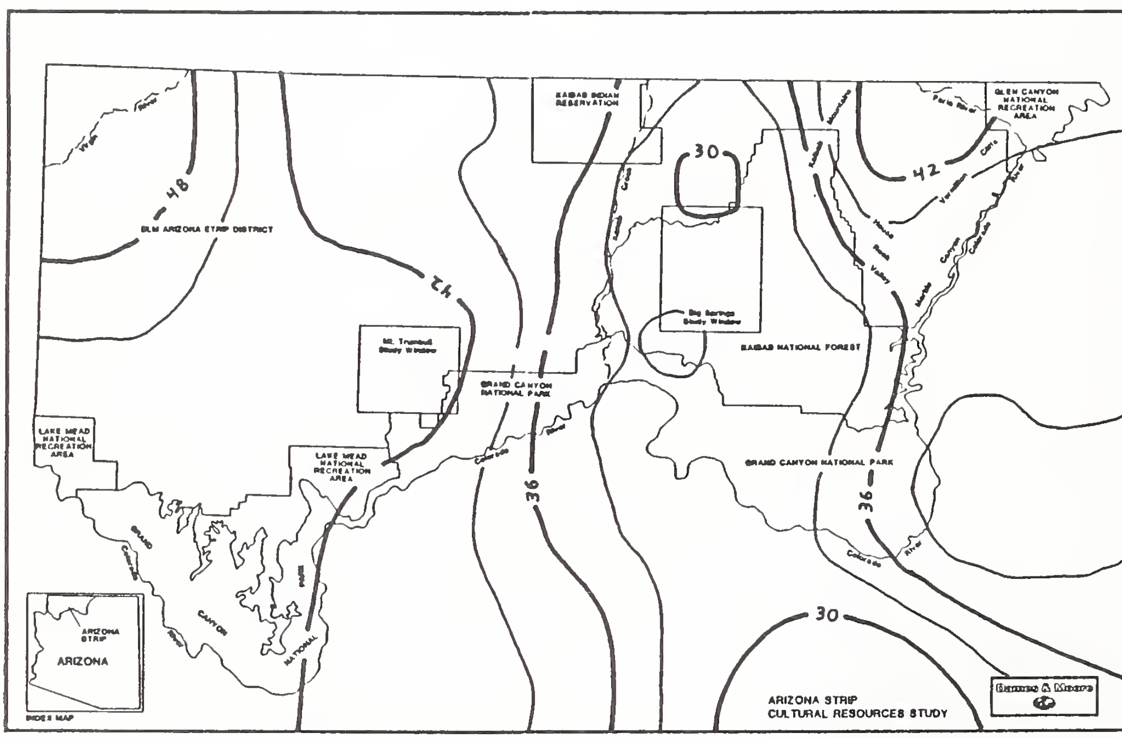


Figure 10. February Temperature.

Table 4. Pearson Product-Moment Correlation Coefficients Between Minimum, Maximum, and Mean Monthly Temperature and Elevation and Longitude. Only values significant at the .05 level are given. Sample size = 17.

	Elevation	Longitude
Min. January	-.81	.68
Max. January	-.90	.71
Mean January	-.90	.72
Min. February	-.88	.56
Max. February	-.98	.54
Mean February	-.96	.57
Min. March	-.89	
Max. March	-.98	
Mean March	-.97	
Min. April	-.86	
Max. April	-.96	
Mean April	-.95	
Min. May	-.86	
Max. May	-.95	
Mean May	-.95	
Min. June	-.85	
Max. June	-.98	
Mean June	-.94	
Min. July	-.89	
Max. July	-.98	
Mean July	-.95	
Min. August	-.91	
Max. August	-.98	
Mean August	-.96	
Min. September	-.88	
Max. September	-.99	
Mean September	-.96	
Min. October	-.86	.49
Max. October	-.98	---
Mean October	-.96	.49
Min. November	-.81	.59
Max. November	-.95	.58
Mean November	-.94	.62
Min. December	-.77	.68
Max. December	-.87	.74
Mean December	-.86	.75
Mean Annual (Oct.-Sep.)	-.95	

Table 5. Regression equations relating long term minimum, maximum, and mean monthly temperatures to elevation and longitude. Only winter months have significant (alpha = .05) relationships with elevation and longitude, therefore the equations have a stepwise form with elevation always entering first. The bivariate coefficient associated with elevation shows the change in temperature with elevation alone. Sample size = 17.

Month	Bivariate Elevation Coefficient	Stepwise Elevation Coefficient	Stepwise Longitude Coefficient	Y-intercept	R^2	Standard Error Estimate
Min. January	-.00257	-.00200	2.419	-240.197	.88	2.82
Max. January	-.00280	-.00227	2.237	-193.269	.96	1.68
Mean January	-.00268	-.00213	2.328	-216.733	.96	1.59
Max. February	-.00306			71.113	.98	1.45
Min. February	-.00307			41.041	.88	3.09
Mean February	-.00336			56.077	.96	1.85
Max. March	-.00408			78.959	.96	1.66
Min. March	-.00322			46.137	.89	2.93
Mean March	-.00365			62.548	.97	1.68
Max. April	-.00412			87.808	.96	2.18
Min. April	-.00316			51.817	.86	3.36
Mean April	-.00364			69.813	.95	2.20
Max. May	-.00423			98.294	.97	1,82
Min. May	-.00368			62.430	.86	3.90
Mean May	-.00395			80.362	.95	2.37
Max. June	-.00433			109.562	.98	1.72
Min. June	-.00397			72.291	.85	4.47
Mean June	-.00415			90.926	.94	2.68
Max. July	-.00452			115.477	.98	1.74
Min. July	-.00403			80.280	.89	3.76
Mean July	-.00427			97.879	.95	2.44
Max. August	-.00448			112.503	.98	1.61
Min. August	-.00400			78.749	.91	3.42
Mean August	-.00424			95.626	.96	2.23
Max. September	-.00415			104.578	.99	1.29
Min. September	-.00366			69.487	.88	3.61
Mean September	-.00390			87.032	.96	2.06
Max. October	-.00382			91.481	.98	1.25
Min. October	-.00309			55.768	.86	3.42
Mean October	-.00346			73.624	.96	1.80
Max. November	-.00312			74.072	.95	1.93
Min. November	-.00246			42.364	.81	3.19
Mean November	-.00279	-.00247	1.351	-95.416	.96	1.48
Max. December	-.00257	-.00197	2.563	-229.642	.87	2.71
Min. December	-.00219	-.00165	2.316	-229.356	.85	2.89
Mean December	-.00238	-.00181	2.440	-229.499	.95	1.67

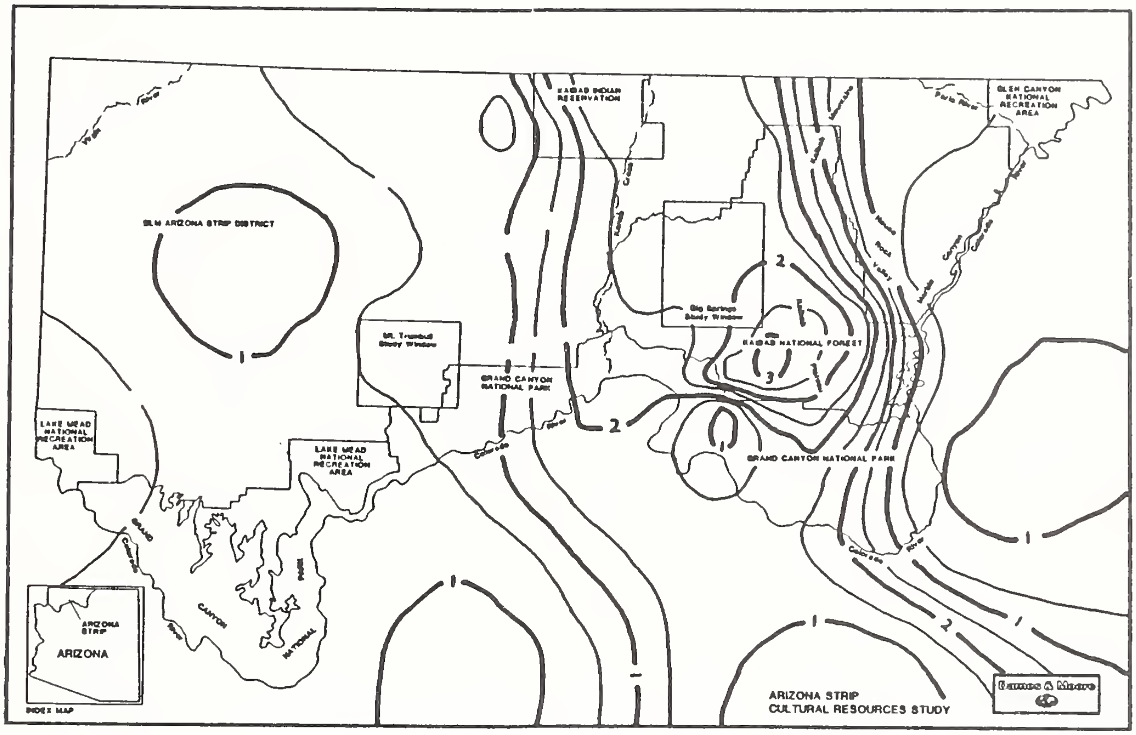


Figure 11. March Precipitation.

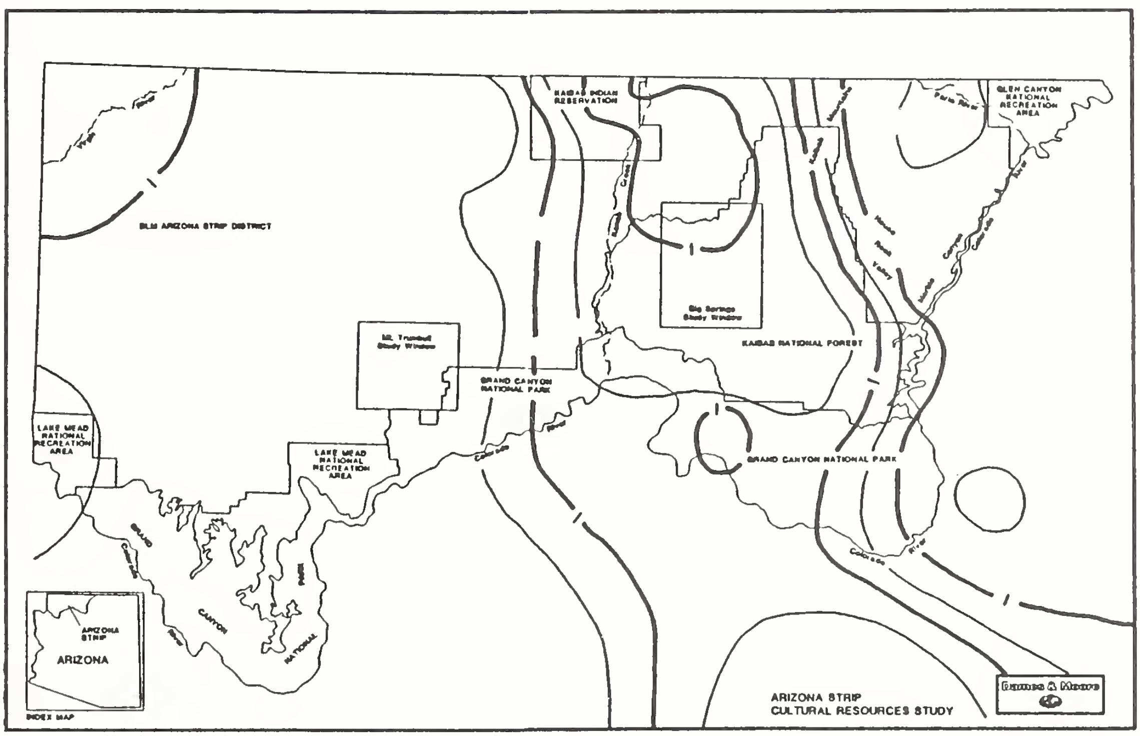


Figure 12. April Precipitation.

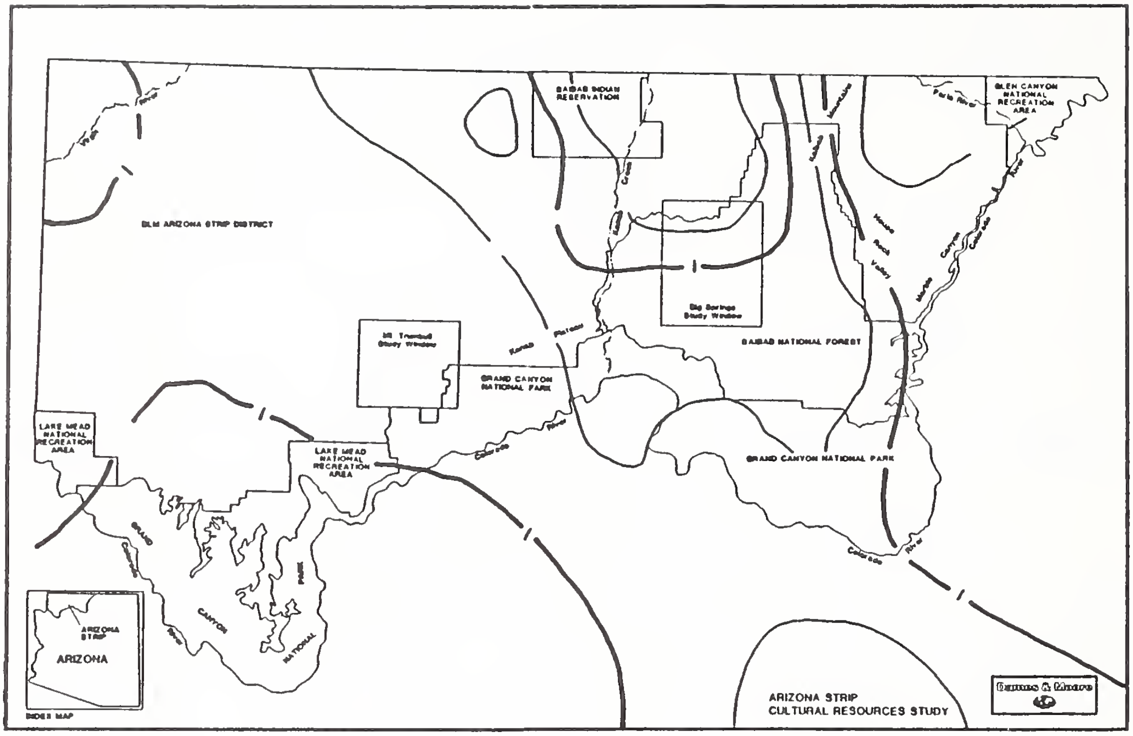


Figure 13. May Precipitation.

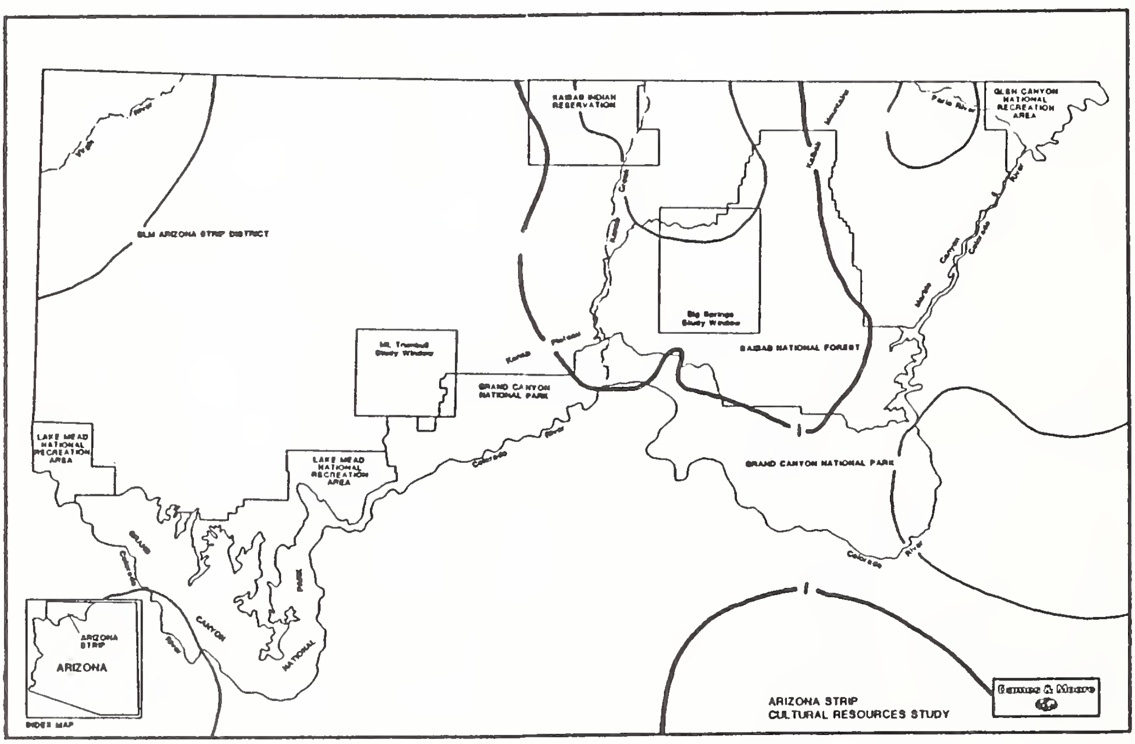


Figure 14. June Precipitation.

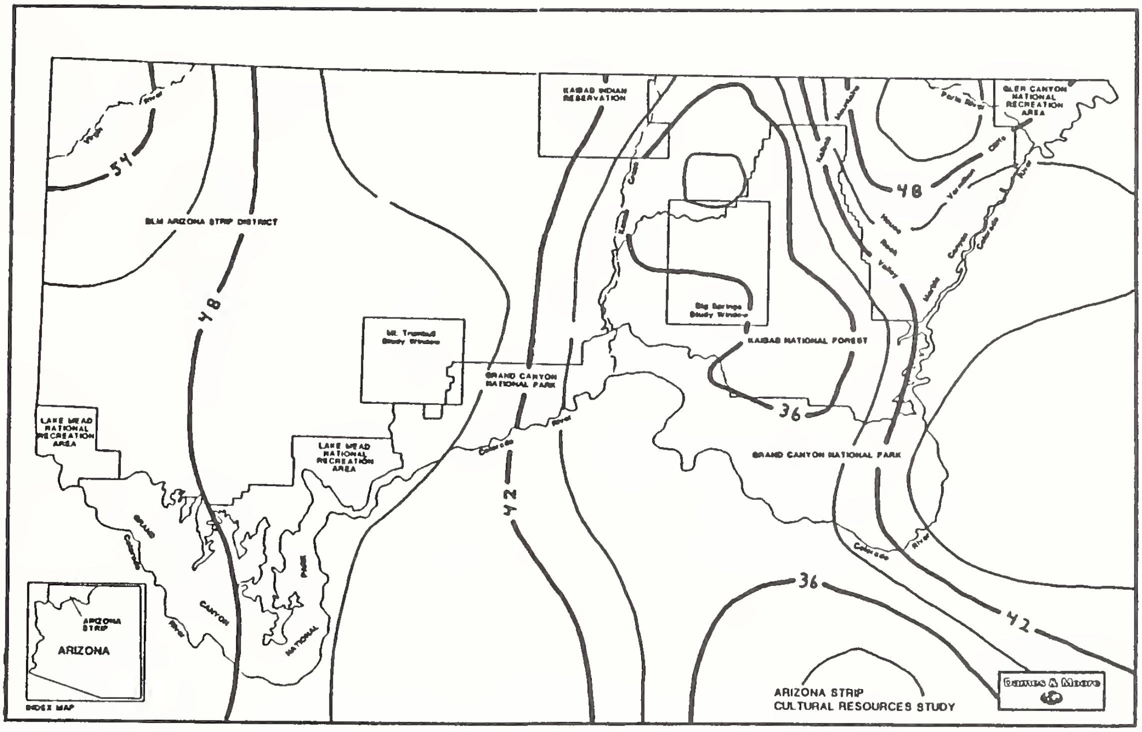


Figure 15. March Temperature.

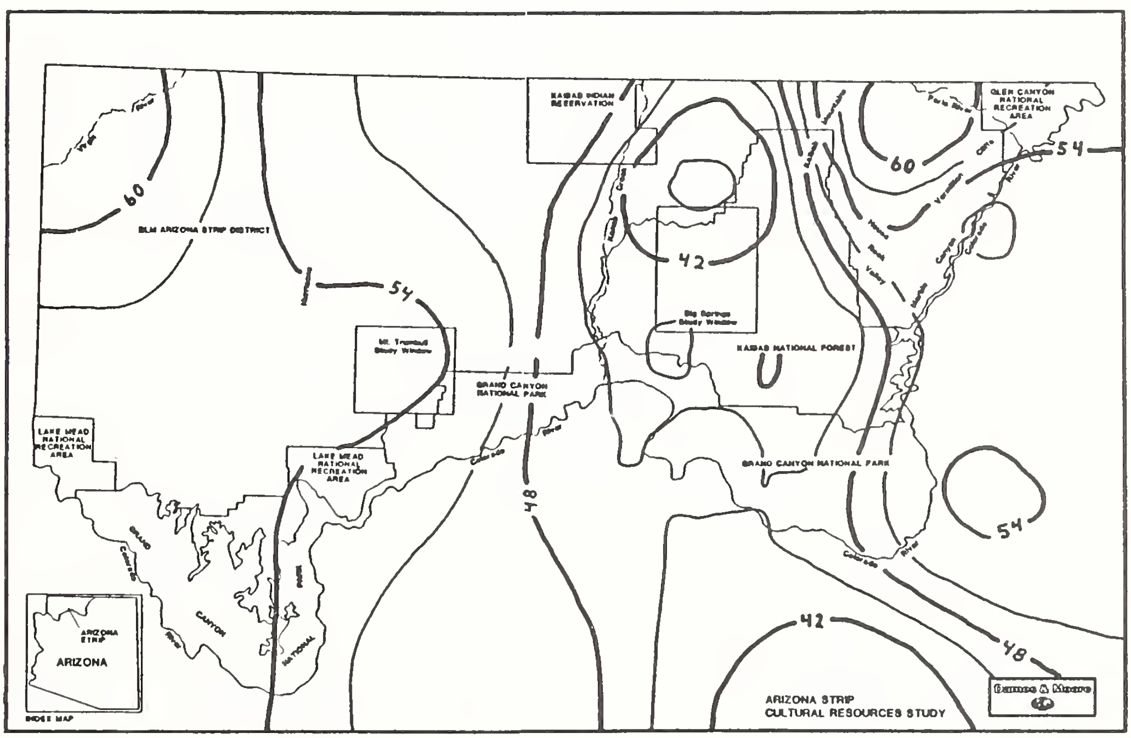


Figure 16. April Temperature.

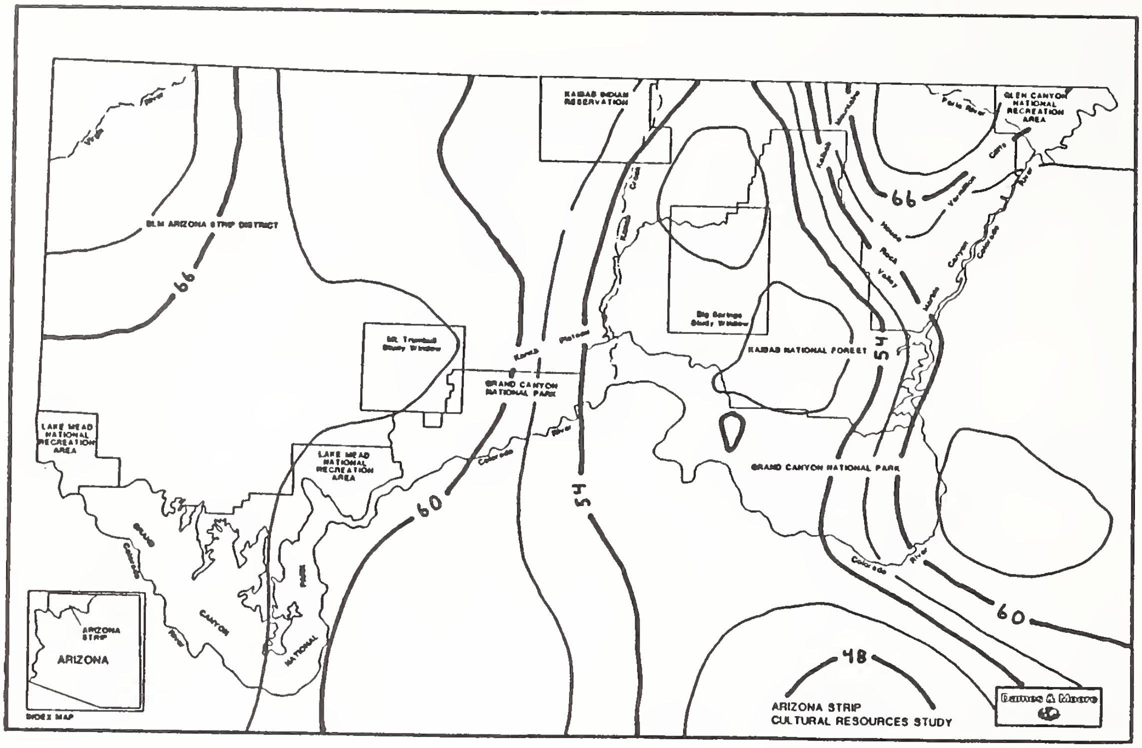


Figure 17. May Temperature.

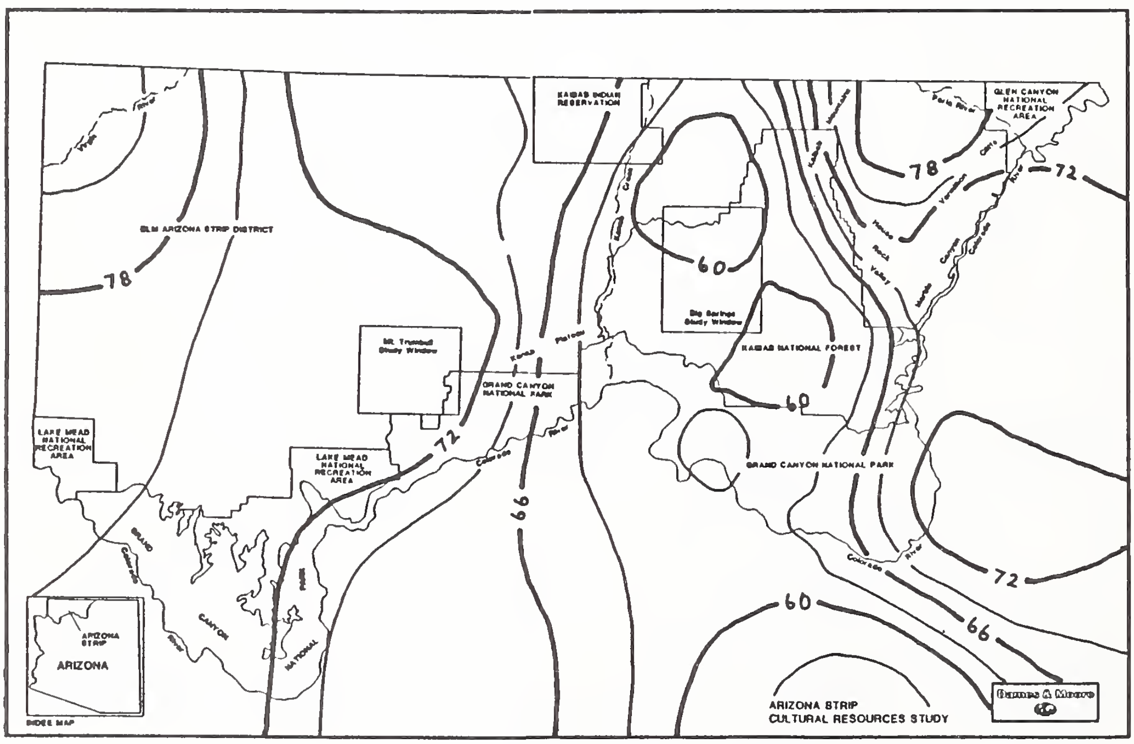


Figure 18. June Temperature.

Summer. Summer normally begins with a rapid atmospheric change. Continental land masses heat up faster than adjacent oceanic areas, resulting in continental lows and oceanic highs. The intense California heat low is usually well developed over the southwestern United States. Maritime tropical air masses are pulled into the Southwest from the Gulf of Mexico and, secondarily, from the Gulf of California and Pacific Ocean. This effectively ends the spring regime of dry air and decreasing pressure. The mass of moist air that moves inland in late June moves west as far as Arizona in August, returning east in September. At its western extreme, it spatially overlaps an area that also receives a great deal of winter precipitation, resulting in high precipitation levels in both winter and summer.

Though most of the moist air is derived from the Gulf of Mexico, some of the heaviest precipitation recorded historically is a result of maritime Tropical Pacific incursions (Bryson and Lowry 1955). Sellers and Hill (1974:14) note that these deep surges of tropical air occur most frequently in late August and September, usually resulting from tropical hurricanes off the west coast of Mexico.

A large amount of the annual precipitation in the Arizona Strip falls during the months of July and August, and to a lesser extent, September. The spatial distributions of total monthly precipitation for the summer months are shown in Figures 19, 20, and 21. On a regional basis, 11.8 percent of the water-year total is received in July, 14.9 percent in August, and 8.3 percent in September. The change in precipitation with elevation for July, August, and September is 0.34, 0.31, and 0.17 in./1,000 ft., respectively.

The warmest month of the year in the Arizona Strip region is July, with a regional average of 75^{O}F., followed by June with an average of 73^{O}F. The mean September temperature of 66^{O}F is about the same as the mean of 69^{O}F in June. Contour maps of summer mean monthly temperatures are shown in Figures 22, 23, and 24. There are no significant correlations between any of the temperature variables (minimum, maximum, or average) and latitude or longitude, but the correlations with elevation are extremely high (Table 4). There is an almost perfect linear relationship between elevation and the summer monthly maximum and mean monthly temperatures, and a lesser but very strong relationship between elevation and the minimum monthly values.

The mean monthly surface temperature gradients are the highest for the year during the months of July and August (4.27 and 4.24^{O}F/1,000 ft., respectively), while September's gradient (3.90^{O}F/1,000 ft.) is similar to May's. The regression equations for estimating the mean monthly temperature values and those for minimum and maximum temperatures are shown in Table 5.

Autumn. Autumn on the Arizona Strip is a brief transition period. The polar front moves south and intensifies at this time, leading to increased storminess in the northern United States. Low pressure systems pass mostly north of the Arizona Strip region, bringing the heaviest precipitation to the Pacific Northwest and the northern Rocky Mountains.

Less than an inch of precipitation (.96 in.), which makes up 7.8 percent of the annual total, falls in the Arizona Strip during the month of October. October precipitation exhibits a moderate correlation with elevation (0.75), with a surface gradient of 0.17 in./1000 ft., but no association with either latitude or longitude. The equation expressing this relationship is given in Table 5. The spatial distribution of precipitation received during this month is shown in Figure 25.

October temperatures represent a transition between the summer and winter months. The regional average temperature is about 55^{O}F, while those of the previous and following months are 66 and 43^{O}F, respectively. The spatial distribution of October mean temperature is shown in Figure 26. Minimum, maximum, and average October temperatures vary predominantly with elevation (Table 4), though about one-fourth of the variability in the minimum and mean values can be explained by longitude.

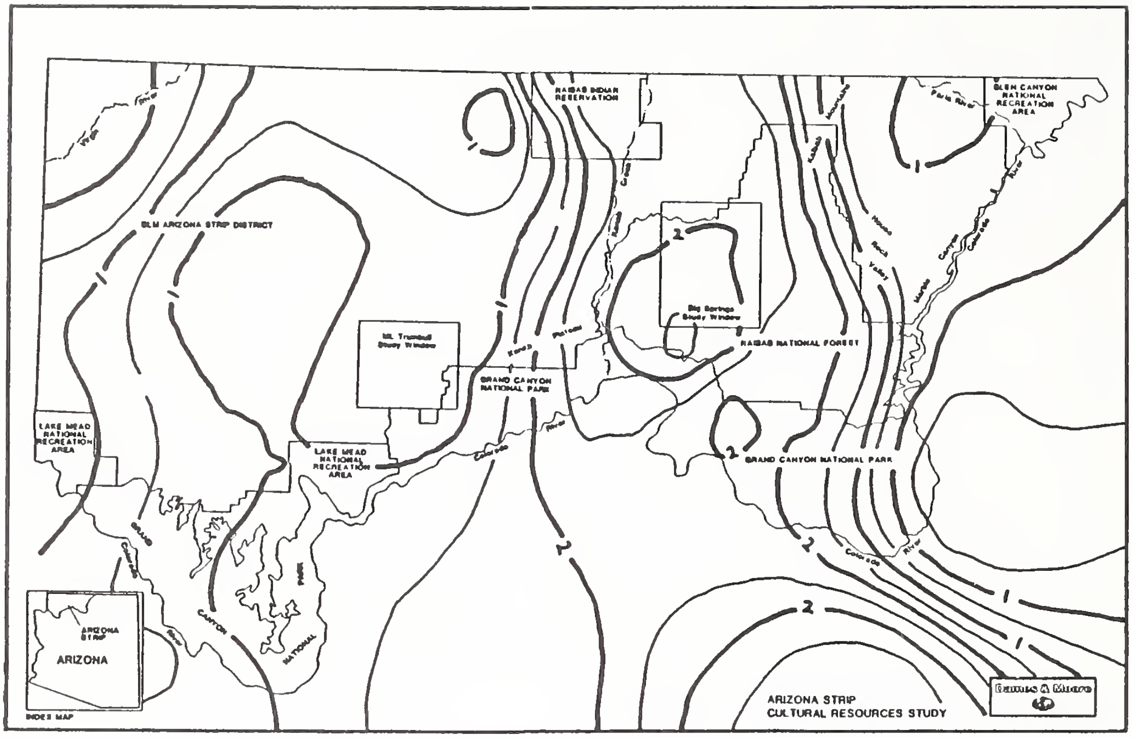


Figure 19. July Precipitation.

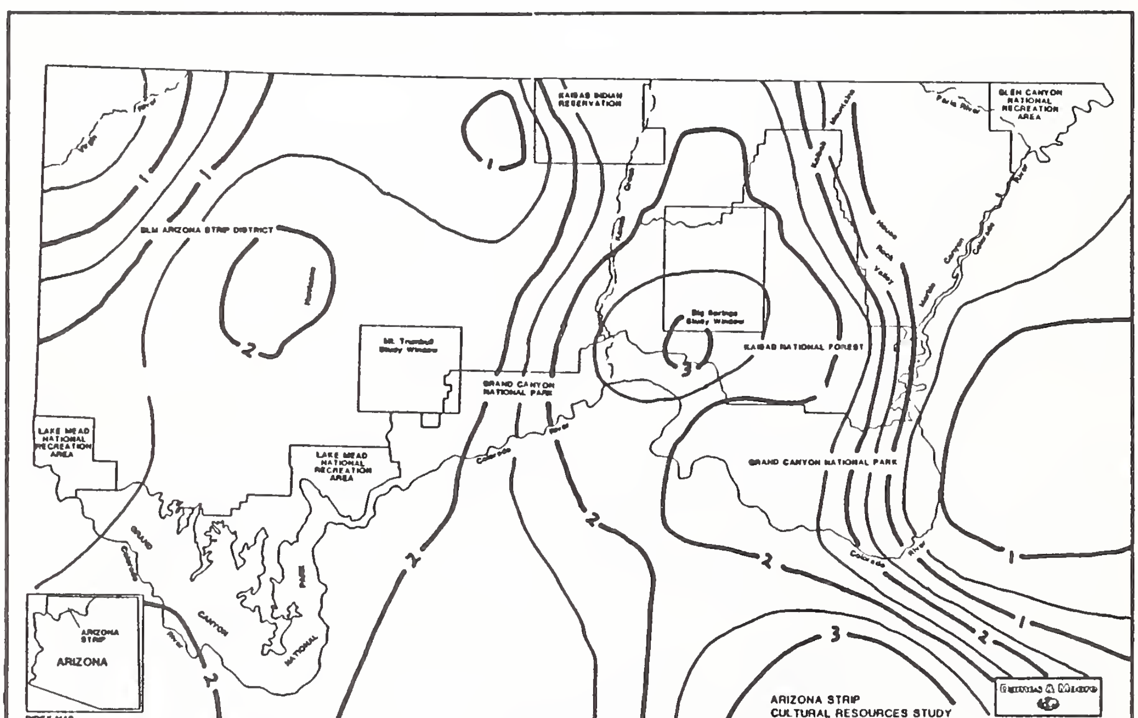


Figure 20. August Precipitation.

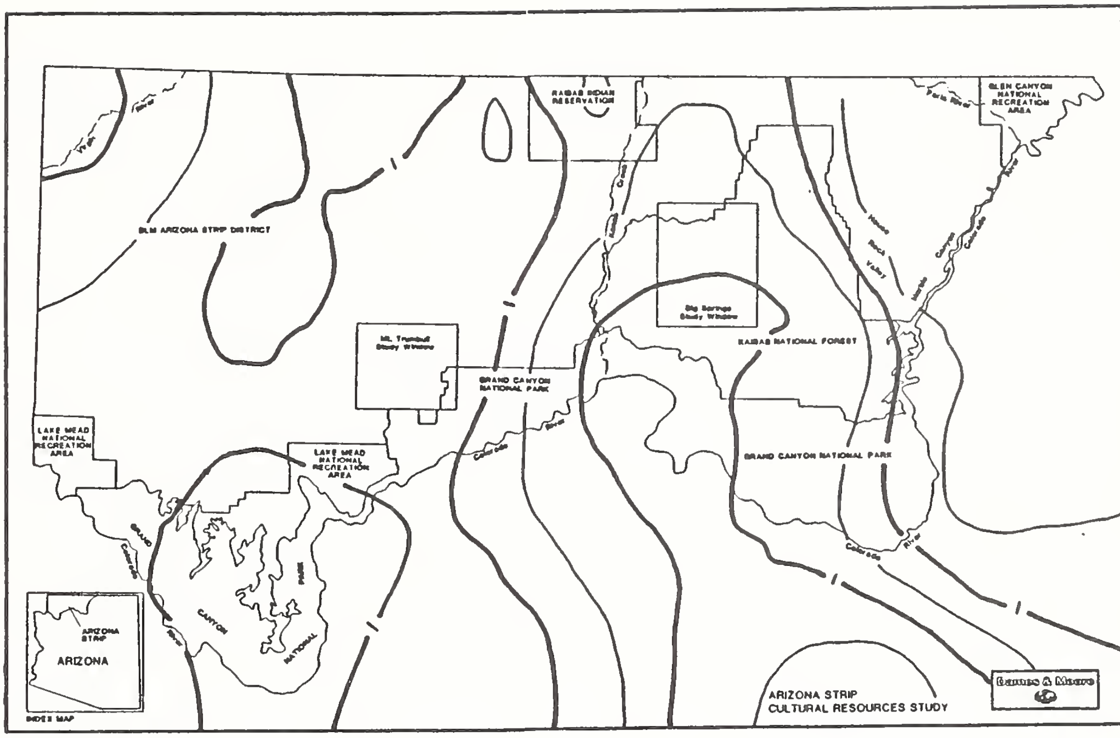


Figure 21. September Precipitation.

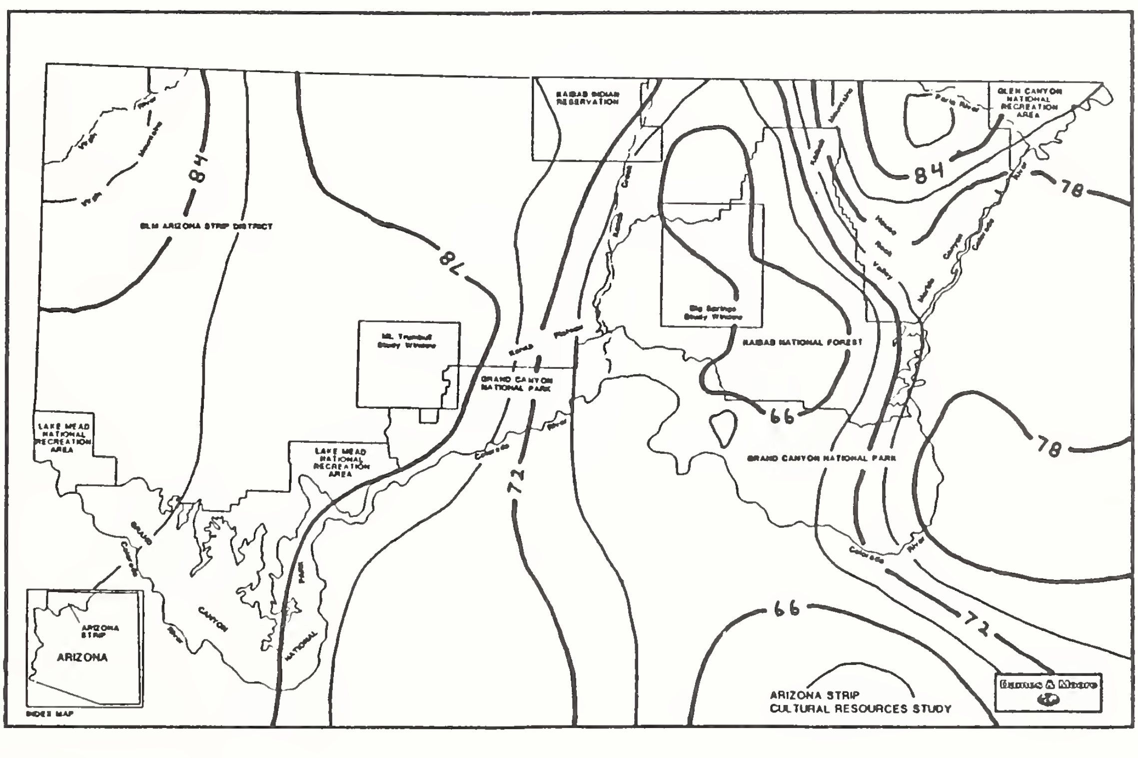


Figure 22. July Temperature.

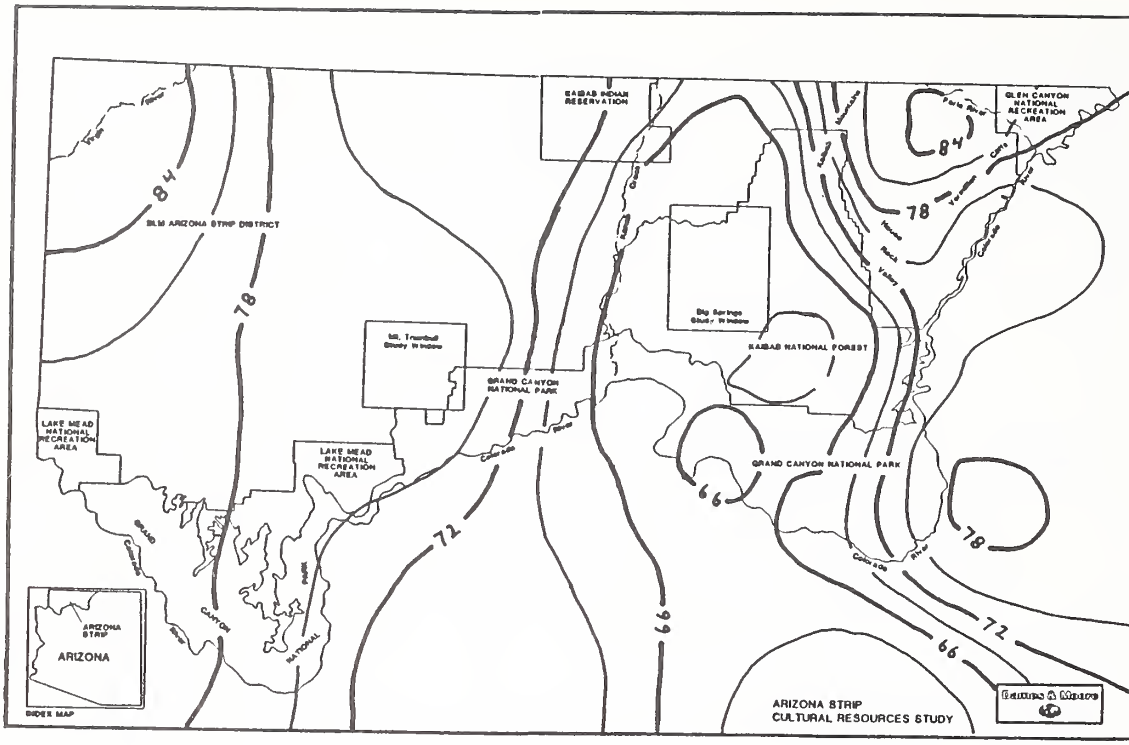


Figure 23. August Temperature.

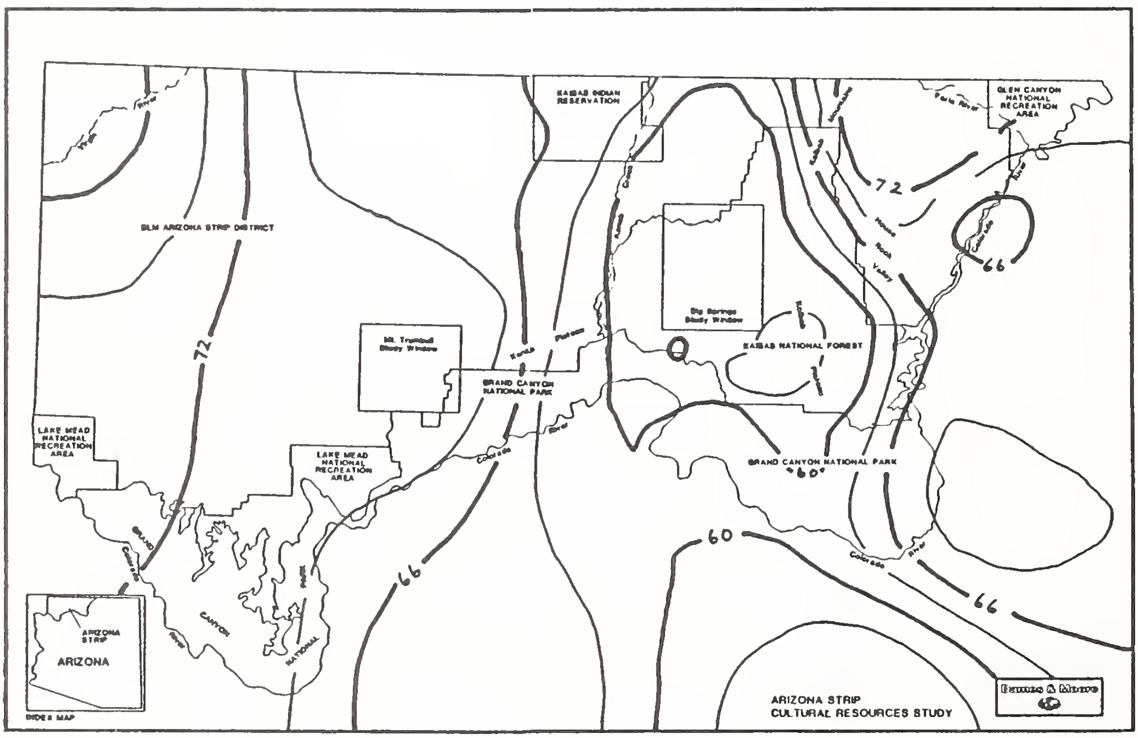


Figure 24. September Temperature.

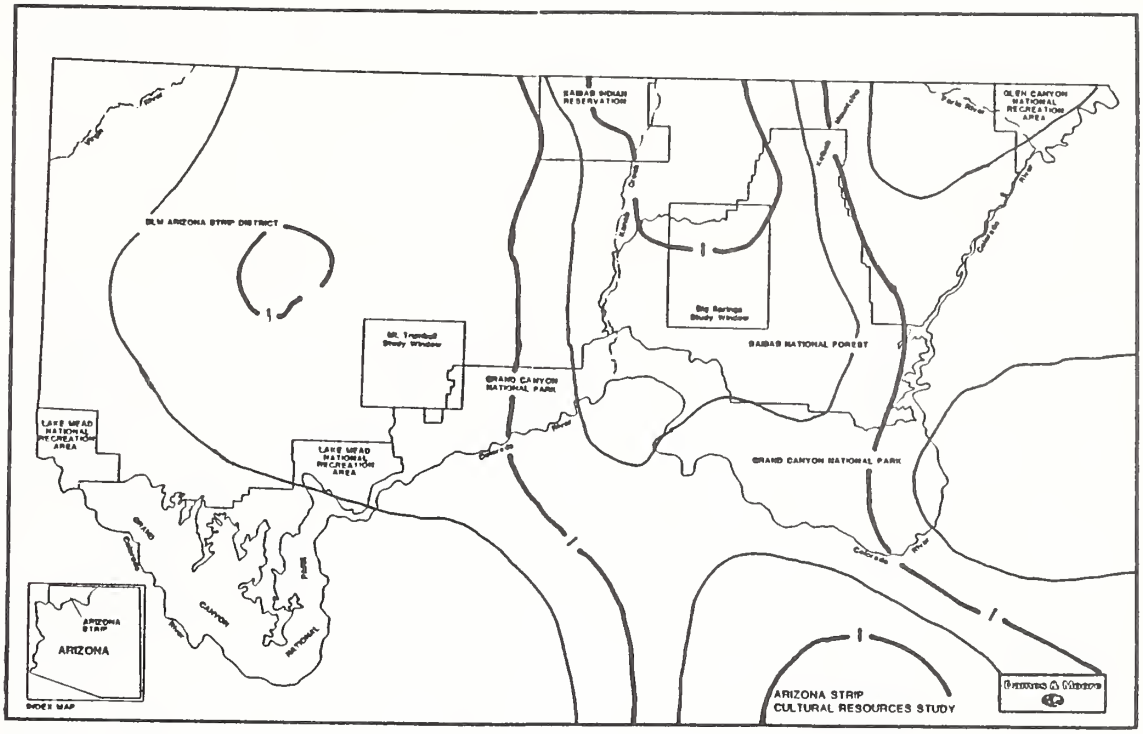


Figure 25. October Precipitation.

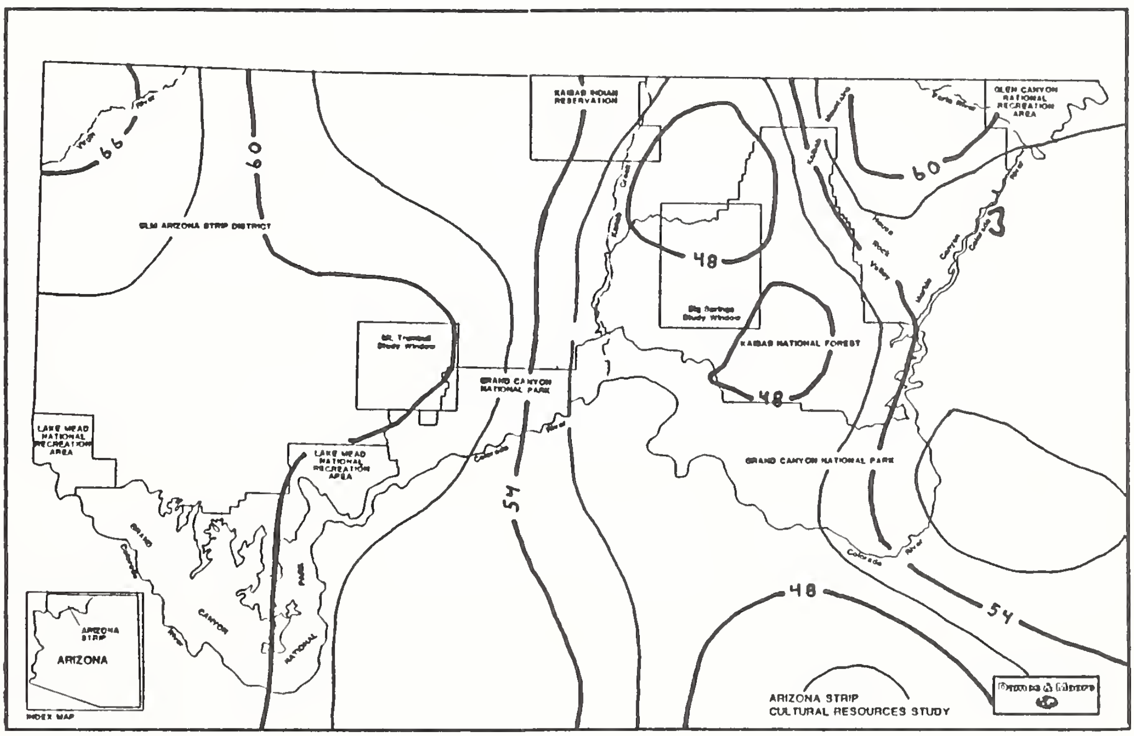


Figure 26. October Temperature.

The western part of the region is warmer than the eastern part, even when elevation is taken into account. The surface temperature gradients for minimum, maximum, and mean October temperatures (Table 5) reflect October's transitory nature and are similar to those of late winter and early spring.

Modern Vegetation

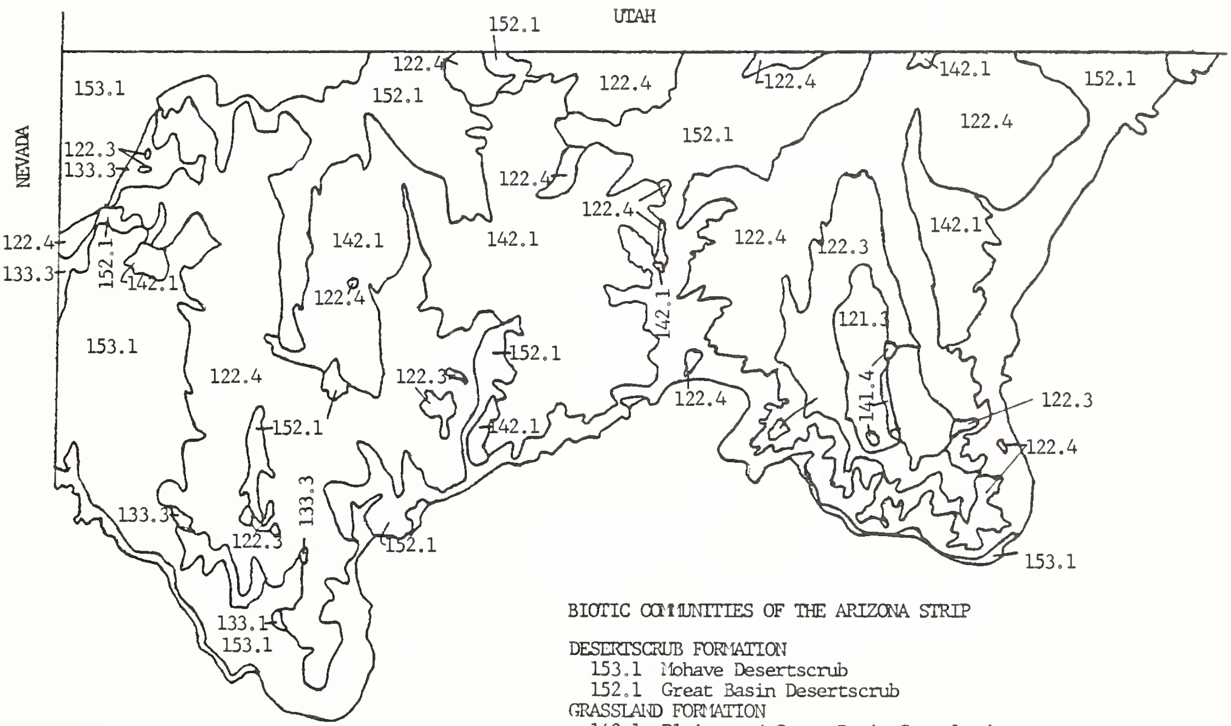
The area defined by the Arizona Strip includes four different vegetation formations -- desertscrub, grassland, scrub, and woodlands (Figure 27). Each of these formations contains many different biomes -- biotic communities characterized by a distinctive vegetation physiognomy. The desertscrub formation incorporates Mohave and Great Basin Desertscrub, while the grassland formation includes the Plains and Great Basin Grassland and Subalpine Grassland. The scrub formation is a very minor component of the regional vegetation picture, and includes both Interior and Californian Chaparral. The woodland formation, present at higher elevations, includes the Great Basin Conifer Woodland, the Rocky Mountain and Madrean conifer forest, and the Rocky Mountain subalpine conifer forest. The classification on which the present discussion is based is summarized by Brown et al. (1979). It is evolutionarily based and hierarchical in structure, and the resulting classifications are therefore natural hierarchies. This discussion of present vegetation communities is presented to establish a baseline for consideration of long term changes, for as will be described later in this chapter, these communities have changed in composition and geographical position over the last 12,000 years. Assembling different plant species into a plant community is the result of the total environment working through time on the available flora. For this reason, vegetation is a delicate integrator of environmental conditions and can be used as an indicator of such conditions.

Mohave Desertscrub

The smallest of the North American deserts is the Mohave Desert, which is characterized by predominantly winter rainfall. It is intermediate spatially and floristically between Great Basin and Sonoran Desertscrub. Mohave desertscrub is present in the far western part of the Arizona Strip, and it forms the region's southern boundary along the Colorado River. The dominant plant series include creosotebush (Larrea tridentata), all-scale (Atriplex polycarpa), brittlebush (Encelia farinosa), desert holly (Atriplex hymenelytra), white burrobrush (Hymenoclea salsola), and a Mohave endemic, the Joshua tree (Yucca brevifolia). Turner (1982b:159) describes the Mohave deserts' evolutionary history and describes the species that serve to separate it from Sonoran Desertscrub. Cacti are well represented in this biome, with species that are widely distributed and others that are more endemic, including a variety of Engelmann hedgehog, mohave prickly pear, silver cholla, beavertail cactus, and many-headed barrel cactus.

This desert also includes many ephemeral plants. Turner (1982b:160) notes that of about 250 taxa falling into this category, about one-third of which are either endemics adapted to winter conditions or are those that germinate and grow in response to summer conditions. Most of the Mohave species fall into the former category.

Within the Mohave Desertscrub biome are five major series: creosotebush, shadscale, saltbush, blackbrush, and Joshua tree. Creosotebush is present in all of the North American deserts, occurring in the Strip region on bajadas and well-drained sandy flats. Its dominance is more a reflection of its height, as opposed to density, in these two-layered communities. The most common codominant is white bursage (Ambrosia dumosa), though other codominants include Anderson thornbush, spiny hopsage, paper bag bush, and shadscale. Elevationally the creosote communities are below about



BIOTIC COMMUNITIES OF THE ARIZONA STRIP

DESERTSCRUB FORMATION
153.1 Mohave Desertscrub
152.1 Great Basin Desertscrub
GRASSLAND FORMATION
142.1 Plains and Great Basin Grassland
141.4 Subalpine Grassland
SCRUB FORMATION
133.3 Interior Chaparral
133.1 Californian Chaparral
WOODLAND FORMATION
122.4 Great Basin Conifer Woodland
122.3 Rocky Mountain and Madrean Montane Conifer Forest
121.3 Rocky Mountain Subalpine Conifer Forest

From: General Technical Report RM-78
Rocky Mtn. Forest & Range Exp. Sta.
U.S.D.A. Forest Service 1980

Figure 27. Vegetative communities of the Arizona Strip.

1,220 m., though in more northerly locations they may reach several hundred meters higher on sCouth-facing slopes. At its upper elevational limit, it is replaced by communities transitional to Great Basin Desertscrub, such as the blackbrush and shadscale series.

The shadscale (Atriplex confertifolia) series is a transitional community centered in the Great Basin Desertscrub. It is present in locations transitional between the Mohave and Great Basin deserts. Shadscale has a wide ecological amplitude. It is tolerant of temperature and rainfall extremes and a wide range of soil conditions.

The saltbush (Atriplex spp.) series communities are characterized by one or more Atriplex species growing with other halophytic chenopods. They occupy habitats that are very arid due to climate, topography, or soil physical properties, or because of soil chemistry.

The blackbrush series communities are dominated by blackbrush (Coleogyne ramosissima). Blackbrush is viewed as being transitional between Mohave and Great Basin desertscrub.

The best known Mohave Desert endemic species, Joshua tree (Yucca brevifolia), has a rather restricted distribution on the edge of the Mohave Desert where it grades upslope into cooler and moister locations. It is sometimes found with species from Great Basin Desertscrub and conifer woodland.

Other associations of small extent occur within Mohave desertscrub, but they are minor in comparison to communities dominated by Creosotebush, shadscale, and blackbrush. The Mohave Desert, in general, has a low species composition compared with the Sonoran Desert to the south.

Great Basin Desertscrub

Great Basin Desertscrub occupies a cool temperate zone that reaches its southernmost limits in the southwestern United States, mostly north of the 36th parallel. In the Arizona Strip this vegetation zone lies above the Mohave Desertscrub and is present throughout the area. This zone defines the eastern boundary of the Strip along the Colorado River, and it is also present in the central and northern parts (Figure 27). Cool temperate deserts are typically found in the rain shadow interiors of the Northern Hemisphere and are characterized by cold, harsh winters, low precipitation, large extremes in daily and seasonal temperatures, saline soils, and low species diversity. Elevationally this desertscrub community lies between 1,200 and 2,200 meters, and in some locations it may extend several hundred meters higher. The dominant vegetation includes low, widely spaced shrubs of sagebrush (Artemisia), Ceratoides, and scattered bunchgrasses (Agropyron, Stipa). These may be joined by blackbrush (Coleogyne ramosissima), winterfat (Eurotia spp.), greasewood (Sarcobatus vermiculatus), or rabbitbrush (Chrysothamnus spp.). There is little cacti, either in terms of species or individuals. Types present include a few chollas, prickly pears, and hedgehogs (Turner 1982a: 145-155).

The sagebrush series includes big sagebrush (Artemisia tridentata), bigelow sagebrush (A. bigelovii), and black sagebrush (A. arbuscula ssp. nova), which is primarily restricted to shallow soils at elevations of 1,500 to 2,500 meters. Big sagebrush occurs in areas of relatively deep soil between 1,500 and 2,150 meters in elevation, while bigelow sagebrush occurs in canyons, gravelly draws, and dry flats. Sagebrush also occurs as a subdominant in Great Basin conifer woodland and grassland.

Plant species on sagebrush sites where little or no grazing has occurred provide valuable references against which grazing effects may be measured. The foliage of species on sagebrush sites is not readily eaten by domestic or native ruminants; its avoidance results in less grasses and forbs and an increase in sagebrush. After burning, sagebrush is slow to reappear, and its position may be taken by more fire adapted species.

Shadscale occurs in the driest Great Basin Desertscrub region, in southern Nevada and southeastern California, from elevations of 990 to 1,775 meters, and farther east at elevations of 1,220 to 1,525 meters. Shadscale communities are open, with the dominant woody plants attaining heights of 0.3 to 0.6 meters, and they grow with less precipitation than adjacent sagebrush communities. This community is widely used for winter sheep range and year round cattle grazing, as it contains some palatable shrubs and perennial grasses.

Blackbrush is present throughout the region, from southern Nevada and southeastern California to north-central Arizona and southeastern Utah. Fire effectively destroys blackbrush, and the plant does not effectively reoccupy burned sites, a condition that favors the establishment of Bromus rubens (foxtail) and B. tectorum (cheatgrass). Perennial grasses are common in unburned stands. Blackbrush occurs on sites with more precipitation than most Mohave desert species, but it does not do well in cold air drainages. Its upper limit on bajadas is probably controlled by low temperatures.

Other minor plant communities are present that are effectively controlled by soil characteristics rather than climate. Dominant species in these communities are members of the families Compositae and Chenopodiaceae.

Plains and Great Basin Grassland

Grasslands showing characteristics of Great Basin intermontane grassland intergrade with plains grassland over a large transition zone including the Arizona Strip. This grassland is present in the central part of the Strip, stretching from just north of the Colorado River to Utah. At low elevations it is in contact with Great Basin Desertscrub, while at upper elevations it comes into contact with pinyon-juniper woodland and montane conifer forest, primarily ponderosa pine. In many locations the grasslands have been altered by the introduction of domestic livestock, but they were formerly open grass-dominated landscapes with the grasses forming a nearly continuous cover. When subjected to fire, a natural succession to climax grass-forb associations took place. Because most of these grasslands are grazed today, there is less residual grassland available for fuel, and the incidence of fire is greatly reduced. The natural succession trend is now usually arrested, being replaced by an association of shrubs (D. Brown 1982b: 115-120).

Subalpine Grassland

Subalpine grasslands are present in the Arizona Strip only as a minor component of the vegetation in the southeastern portion. They occur on valleys, slopes, and ridges, usually on flat or undulating terrain adjacent to and within subalpine conifer forests. Well drained sites are dominated by perennial bunchgrasses (Festuca, Agropyron, Stipa, Poa, and Muhlenbergia) accompanied by forbs. Little of this grassland is in a climax condition because of grazing or, less commonly, fire. On cattle ranges, less palatable forbs and grasses tend to increase while native bunchgrasses decrease, and on sheep range secondary grasses can be expected to replace forbs. At lower elevations and on poorer ranges, shrubs like big sagebrush may be abundant.

Interior Chaparral and Californian Chaparral

Interior and Californian Chaparral occupy a relatively minor and restricted area in the western part of the Strip. Shrubs in these two communities represent a wide range of families and species, but they share a number of adaptations, including dense compact crowns, small, hard, thick evergreen leaves, and deep widespread root systems (D. Brown 1982b:85). They are usually well adapted to fire and either reproduce prolifically after burning or sprout from root crowns.

Californian Chaparral may include chamise (Adenostoma fasciculatum), ceanothus, manzanita, and scrub oak, while Interior Chaparral contains scrub oak as the dominant species.

Great Basin Conifer Woodland

Conifer woodland is present in the eastern, western, and north central parts of the Arizona Strip (Figure 27). It is a cold-adapted woodland characterized by the unequal dominance of juniper (Juniperus) and pinyon (Pinus) (Brown 1982a:52-57). Juniper tend to grow at lower elevations than pinyon, and normally occupy sites with deeper soil below 2,000 meters. They are typically open spaced except at higher elevations and more mesic locations where the coverage can be more dense. The most common pinyon is Rocky Mountain pinyon (Pinus edulis), though west of longitude 113.5^{o} it is largely replaced by single needle pinyon (P. monophylla). One-seed juniper (Juniperus osteosperma) may be the most common of the junipers, though at higher elevations and in more localized situations, Rocky Mountain juniper (J. scopulorum) can occur.

In some areas, Great Basin Conifer Woodland meets grassland, and areas are characterized by parkland and savanna-like mosaics. The openness of these parklands or savannas depends on soil type, range history, and condition. Understory is typically grasses and shrubs. At other locations on the eastern part of the Strip, and at lower elevations, conifer woodlands meet Great Basin Desertscrub. In this context, big sagebrush is often the most frequent understory plant. In the more western part of the Strip, conifer woodland occurs on the mountains above Great Basin and Mohave Desertscrub. On ranges above 1,500 m. within and adjacent to the Mohave desert, blackbrush is a common understory component of pinyon-juniper woodland. Other shrubs that may be important subdominants include cliffrose, apache plume, mormon-tea, barberry, fourwing saltbush, small soapweed, and datil. Other species such as buffalo-berry, antelope bitterbrush, and fernbush have more local occurrences. Herbs and grasses commonly encountered include gilias, buckwheats, sego-lily, penstemons, globemallows, lupines, and bromes. Several cacti also have the conifer woodland as their center of distribution or are otherwise well represented. These include hedgehogs, prickly-pears, and chollas.

Rocky Mountain and Madrean Montane Conifer Forests

Included in this classification are the Transition Zone, consisting of pine forests, and the Canadian Zone, where firs grow. Stands of pine and fir are extensive in the southeastern part of the Arizona Strip, but are scattered in the western portion. On almost all of the Strip, the conifer forest zone lies above the Great Basin conifer woodland and can be divided into two major communities. Ponderosa pine (Pinus ponerosa) forest is found at lower elevations. At higher elevations, on north-facing slopes, and in canyons, a cooler, mixed-conifer forest of Douglas-fir (Pseudotsuga menziesii), white fir (Abies concolor), and aspen (Populus tremuloides) occurs.

Ponderosa pine forest is the most common montane tree in the Southwest and often grows in pure stands. Old growth ponderosa forests are often park-like, with grassy or herbaceous understories. Lightning fires probably kept the forest more open in pre-Anglo settlement times, though with fire suppression the stands are denser and younger. The ponderosa pine forest grows on a wide variety of soils and geologic parent materials, including andesite, basalt, granite, diabase, limestone, and sandstone.

At middle and higher elevations, ponderosa pine may be associated with southwestern white pine (Pinus strobiformis), Douglas-fir, white fir, and quaking aspen. At lower elevations and on rocky sites, gambel oak (Quercus gambelii) may be an important component of the community. In older undisturbed forests at higher elevations, fir may be an understory component. Understory shrubs are few and not especially dense, and in more open stands grasses and grass-like plants may be common.

The mixed conifer forest, or Douglas-fir-white fir forest may occur in pure stands above the more extensive pine forests, but most often it is mixed with firs or spruce near its upper limit. Mature mixed conifer forest is often dense, with high canopy cover and a heavy litter accumulation that restricts undergrowth. A depauperate understory may develop where there are openings in the canopy, and where litter accumulation is not too great the understory may contain shade-tolerant species.

Quaking aspen is a minor but important subclimax community in the conifer forests of the Southwest. Aspen does not tolerate shade and reproduces primarily from root sprouts when the overstory conifer forest is removed through fire, blowdown, or harvesting.

Rocky Mountain Subalpine Conifer Forest

Subalpine conifer forest falls within the Hudsonian Zone and is essentially equivalent to spruce-fir forest (Pare and Brown 1982a:37-39). It is primarily restricted to the southeast part of the Arizona Strip, lying above the ponderosa and mixed conifer forest (Figure 27). Engelmann spruce (Picea engelmanni) is the dominant spruce throughout the Southwest, where it grows with either subalpine fir (Abies lasiocarpa) or corkbark fir (A. lasiocarpa var. arizonica). These forests are wet and cold. Much of the precipitation falls during the winter as snow, although summer precipitation contributes substantially to the total. The lower contact of this zone with Rocky Mountain montane conifer forest is often indistinct and poorly differentiated, intermingling with Douglas-fir, white fir, and ponderosa pine. The nature of this contact depends on elevation, slope, exposure, and location.

Dwarf juniper (Juniperus communis) is an understory shrub often associated with the spruce-fir forest. Shrubs are otherwise poorly represented except in certain seral stages, natural openings, and at the edge of the forest. Where the forest is closed, duff and debris may preclude the development of a herbaceous understory, which is more commonly present where the forest is opened up after fire or logging.

Summary of Modern Conditions

As the preceding discussion indicates, the Arizona Strip encompasses a wide range of environmental zones. The area is characterized by its harshness and its unpredictability. In terms of human occupations past and present, the environment has exerted, if not a controlling effect, certainly a strong influence.

Perhaps the most striking aspect of climate on the Arizona Strip is the degree to which temperature and rainfall are controlled by elevation. To complicate this picture, the Strip lies on the present monsoon boundary, which results in a highly bimodal precipitation pattern consisting of winter and summer rainfalls. The exact location of the monsoon boundary in any given year is controlled by complex atmospheric conditions that affect the entire northern hemisphere. Slight changes in these controlling factors can lead to major shifts in climatic conditions. Thus, it is not uncommon to experience vast swings in weather from one year to the next. This fact is important to keep in mind, not only to understand modern conditions, but also for assessing paleoclimatic patterns.

Given the boundary position of the Arizona Strip in terms of the monsoon, it is not surprising to find that climate has a much stronger effect on vegetation here than in surrounding areas. Short-term climatic fluctuations probably have little effect on vegetative communities because these communities generally respond very slowly to change. We would, however, expect to see vegetative communities respond to global or hemispheric fluctuations.

PAST ENVIRONMENTAL VARIABILITY ON THE ARIZONA STRIP

The preceeding discussion of the modern environment on the Arizona Strip serves as a synchronic view of climatic variability. In this section our attention turns to examining how this synchronic view changed over time. In this pursuit we are fortunate, for in the vicinity of the Arizona Strip, considerable research has been performed on environmental reconstruction covering portions of the past 12,000 years. Little research has been conducted on the Arizona Strip per se, however, so any paleoenvironmental synthesis of the Strip must of necessity consider research undertaken in the surrounding area.

A large amount of paleoenvironmental reconstruction covering the time period relevant to this report has been done with plant macrofossils recovered from indurated woodrat middens. These reconstructions are by and large based on research done in the Grand Canyon, west of the Arizona Strip in the Mohave Desert, in southeastern Utah, and to the east on the Colorado Plateau. Considerable alluvial geochronological research covering the past one to two thousand years has recently been undertaken in the area around Escalante, Utah and on Black Mesa, in northeastern Arizona. In northwestern New Mexico and southwestern Colorado, considerable effort has been expended over the past 25 years on alluvial geochronological and archaeological pollen research. Much of this earlier work has stimulated some of the questions that are being asked in current investigations relating environmental variability and changes to human ecology. Dendrochronology and dendroclimatology originated from research in the Flagstaff area and southeastward along the Mogollon Rim. Since the early part of this century, dendroclimatological research covering the past 1,500 years has been extended to the rest of the Southwest and the West.

In this section we explore the various methods scientists use to study past environmental conditions. We also summarize the results obtained through these methods as they apply to the Arizona Strip and surrounding regions. Our discussion begins with tree-ring evidence, which can be used to study the relatively high frequency of paleoclimatic variability over the past 1,000 years. The use of palynological information is then reviewed. Chronostratagraphic studies with reasonable temporal control are examined next. We explore the results of such studies from in and around Black Mesa in northeastern Arizona, in the vicinity of Escalante, Utah, and along the Paria River. Earlier alluvial geochronological studies in the Navajo Reservoir district along the northwestern New Mexico-southwestern Colorado border are also addressed. Finally, we discuss packrat midden studies that have been undertaken on the north and south sides of the the Grand Canyon, in southeast Utah, and the eastern Mojave desert.

Important Considerations in Paleoenvironmental Summaries

Temporal and spatial comparisons and integrations of different paleoclimatic indicators may be complicated by four factors; the accuracy and precision with which they are dated, environmental sensitivity, response time, or data incongruencies. As to dating, different indicators have different temporal resolutions because of different chronological controls. For example, tree-rings are accurately dated to the year in which they were produced, and they yield climatic information on a yearly and seasonal basis. In contrast, pollen samples normally represent pollen rain aggregated over a long time period, which is normally dated using radiocarbon analysis.

A second factor to consider when evaluating paleoclimatic data is environmental sensitivity. Environmental change may be detected in one pollen record, but not another from the same region. For example, a pollen record obtained from a pinyon-juniper forest could yield a different paleoclimatic reconstruction than one taken from a nearby spruce-fir forest.

A third factor that must be evaluated is response time. Response time is a measure of how quickly a paleoclimatic indicator responds to changes in environmental conditions. Tree rings respond quickly to variability in precipitation, temperature, and soil moisture conditions. In comparison, pollen records have a long lag response because the different species in plant communities usually respond to climatic shifts at slower rates. It is thus conceivable that the same climatic inputs over a period of time, whether it be a year or a century, can yield vastly different but complimentary responses from different environmental indicators.

Dean (1984:8-20) has recently addressed the problem of varying response times by separating environmental variability in archaeological contexts into those resulting from low frequency processes (LFP) with periods of longer than one human generation (about 25 years) and those deriving from high frequency processes (HFP) characterized by shorter term variability. LFP are responsible for phenomena such as alluviation and erosion in fluvial systems, while HFP are responsible for seasonal and annual climatic variability. Low frequency processes are usually not apparent to humans in the absence of permanent records, and environmental conditions created by low frequency processes are probably regarded as stable during an individual's lifetime. High frequency processes are apparent to human populations, and most behaviorial buffering mechanisms such as the development of storage facilities, water control devices, and economic redistribution systems are adaptations to high frequency variability in the environment.

Finally, incongruencies in the data need to be evaluated. Almost all paleoenvironmental data sources have the potential to present biased pictures of environmental changes because of sampling problems. The question that must be asked of each paleoenvironmental indicator is to what extent the samples permit generalizations to the larger population. More specifically, to what extent do samples obtained from a particular environmental strata allow inferences to be made to a larger or nearby area, different elevational zones, or different ecological contexts. For example, tree-ring chronologies over most of the Colorado Plateau normally have a great deal of variance in common, that is, they are highly correlated with one another. Therefore, the general aspects of a dendroclimatic reconstruction at one location in the Four Corners region may reasonably represent variability over a much larger area. Alternatively, an attempt to reconstruct climatic variability from pollen obtained from archaeological sites may be hindered by the effects of agricultural intensification and disturbance, the manner in which architectural barriers affect pollen dispersal, or the removal of local forest for firewood and land clearing. Packrat middens also have potential shortcomings (Betancourt 1987:129), in that the middens do not persist in areas of high rainfall or high elevations, they preserve better in some substrates (limestone) than others (sandstone, granite), and they are restricted to rocky environments. Additionally, different species of packrats have different food preferences. In presenting a paleoenvironmental synthesis of the Strip region, we will address the strengths and weaknesses of the different environmental proxies, or indicators, with respect to the factors mentioned above.

Dendroclimatology

Dendroclimatic research in the Colorado Plateau region enjoys a relatively long history within the young science of dendrochronology, which deals with the dating and study of climate-induced variability in sequences of wide and narrow annual growth layers in wood. The historical and conceptual background of archaeological tree-ring dating is reviewed in detail by Dean (1978:129-163). The relationship of tree-ring dating and archaeology in the American Southwest has been examined by Robinson (1976:9-20).

Expanded tree-ring chronologies formed from two data sets, archaeological specimens and living trees, provide some insight into high frequency paleoenvironmental changes in the Arizona Strip region over the past thousand or so years. Dean and Robinson (1978:1) note that although comparable in terms of the resultant chronology, they are assembled from different collections of raw data. The procedures involved in this operation are outlined by Dean and Robinson.

Recent dendrochronological collection activities in the Arizona Strip region by staff of the Laboratory of Tree-Ring Research at the University of Arizona indicate a strong potential for developing chronologies that are 700 to 800 years in length from currently living trees (Alex McCord and Thomas W. Swetnam, personal communication 1987). Chronologies of this length and longer are required to merge with archaeological chronologies from the same general area, when they exist. Several 700- to 800-year-old pinyon and ponderosa chronologies are being developed from sites in the vicinity of Mt. Bangs and Wolf Hole Mountain. Additional chronologies may be developed from other recently sampled tree-ring sites in northwestern Arizona.

Graybill (1985) has also recently constructed several well replicated (based on a large number of radial core samples) millennia-long bristlecone pine chronologies from nearby areas, including the San Francisco Peaks near Flagstaff, Charleston Peak near Las Vegas, and Mammoth Creek, near Panguitch, Utah. Additional chronology building efforts using standing snags and remnants of deadwood could potentially add even more age to the bristlecone chronologies. Graybill (1985) is currently attempting to isolate the precipitation and temperature responses of these chronologies in order to determine which climatic variables might be reconstructed, while simultaneously addressing several difficult statistical problems that those variables present in establishing mathematical equations relating tree-rings to climate.

Other tree-ring chronologies from the Arizona Strip region were obtained from earlier sampling activities by the Laboratory of Tree Ring Research during the middle and late 1960s. Stokes and Harlan (Drew 1972:5-6) developed three pinyon chronologies from Mount Trumbull, June Tank, and Tuweep at elevations of 6,500, 5,600, and 5,750 ft., respectively. These chronologies begin in the relatively late years of A.D. 1620, 1700, and 1730, are based on few specimens (six maximum and generally only a few in the earliest years), and are currently of limited usefulness for any future paleoclimatic reconstructions because of their poor specimen depth. Along with the chronologies currently being constructed for the western part of the study area, however, they demonstrate a relatively unexploited potential for tree-ring studies based on locally procured materials.

Although there are no dendroclimatic reconstructions currently in existence that are based on tree-ring materials from the Arizona Strip, such reconstructions do exist from some adjoining regions.

Moreover, due to the extremely high amount of variance held in common by chronologies in the Four Corners region, the relative dendroclimatic reconstructions described by Euler et. al. (1979) and Dean (1984) can be regarded as reasonable approximations of paleoclimatic variability in the Strip region.

Dean and Robinson (1977) studied dendroclimatic variability in the southwest for the years from A.D. 680 to 1970. Twenty-five chronologies were converted to decadal departure values and contoured to show areas of relatively high and low growth in the general Colorado Plateau region. It must be noted that the contour maps presented by Dean and Robinson (1977) extend to 38 degrees north latitude and 113 degrees west longitude, ostensibly including the central and eastern part of the Arizona Strip. Because none of the twenty-five chronologies are actually located in the area north and west of the Colorado River, however, the contour lines on the map represent interpolations heavily weighted toward the nearest chronologies.

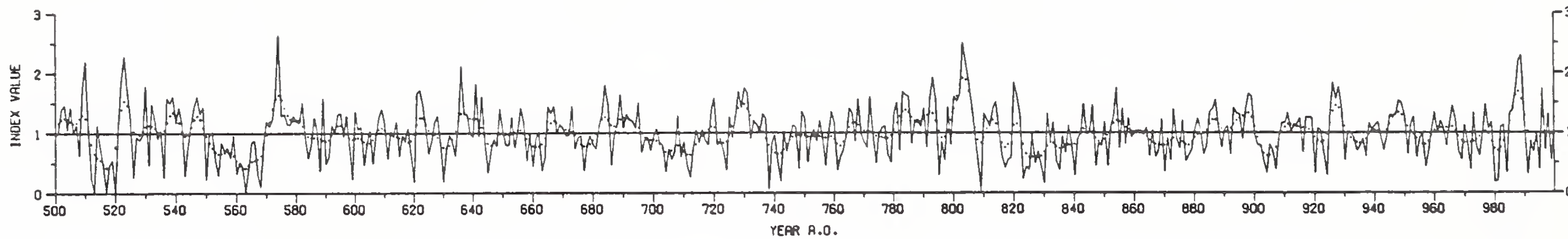
Five expanded chronologies are located south and east of the Arizona Strip. These chronologies are from Natural Bridges, Navajo Mountain, Tsegi Canyon, the Coconino Plateau, and Flagstaff. The contour lines for the Arizona Strip area for certain decades are based on interpolations from even farther away than the chronologies mentioned above, since there are gaps between the archaeological and living-tree chronologies. In the Natural Bridges chronology, there is only a five year overlap between the archaeological and living tree components. At Flagstaff the overlap is 1 year, and at Tsegi Canyon it is 22 years. The Navajo Mountain expanded chronology has a 199-year gap between the archaeological and living-tree series, while a 325-year interval is present between the archaeological and living tree components of the Coconino Plateau chronology. Therefore, in using the decadal dendroclimatic departure maps to make inferences about relative changes of climate in the Arizona Strip, archaeologists should be aware that the values may not be based on local tree-ring chronologies. This is not necessarily a detraction, since most of the chronologies over the Four Corners region are highly correlated, but one must recognize that local variations may not be represented.

The chronologies described above are also based on different numbers of specimens at different points in time. A reasonably large number of specimens is available from the present back to the early parts of the living tree chronologies, usually three to five hundred years, and during the period of prehistory in which the different locations were more intensively occupied. The Natural Bridges chronology has less than five specimens between A.D. 94-110, 224-419, and 1257-1489. Similarly, the Navajo Mountain chronology is based on less than five specimens from A.D. 340-343, 640-879, and 1252-1490, while the Tsegi Canyon chronology drops below five samples for the years between A.D. 381-587, 597-757, 846-909, 916-919, 1057-1148, and 1277-1326. The Coconino Plateau chronology is based on less than five specimens from A.D. 610-691, 700-704, 773-834, and 1066-1619, and the Flagstaff chronology drops below five between A.D. 570-734, and 1167-1551. As numbers of specimens in a sample decreases, the standard error of the annual index values increases, and the year-to-year values become more variable, a statistical constraint that should not be mistaken for climatic variability.

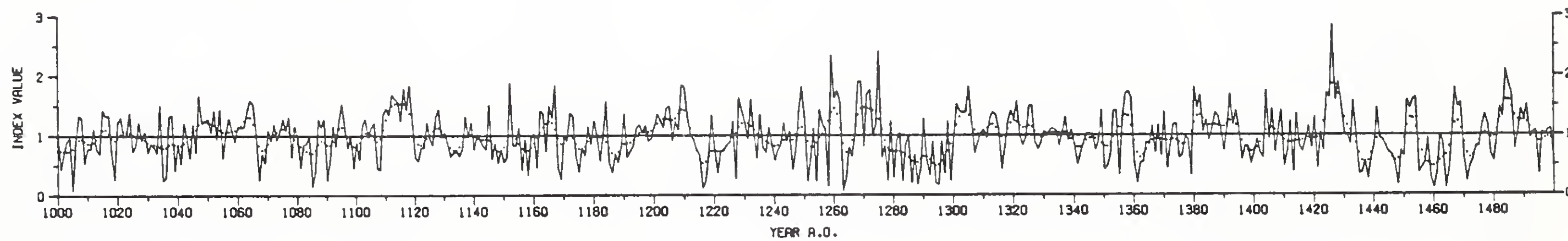
The pinyon chronology from the Hopi Mesas area begins in A.D. 500 and ends in A.D. 1971. Like the other chronologies described above, it has years when the sample size drops below five specimens, but it does not have a gap between the living tree and archaeological components. Years where the sample size is small include A.D. 500-623, 1074-1189, 1283-1305, and 1425-1469.

A plot of this chronology from A.D. 650 to 1971 is shown in Figure 28 (mean is 1.0 and standard deviation is 0.432). The plot includes the actual index values and a heavier smooth line showing the low frequency variability. The smooth line results from the application of a low-pass digital filter to the actual indices. This low pass digital filter, sort of a sophisticated moving average, excludes the high frequency variance and shows changes with periodicities greater than about eight years. It was described in greater detail by Fritts (1976). The plot can be regarded as a general index of effective moisture conditions, such that large values above the mean represent cool/moist periods and small

TREE-RING INDEX
HOPI MESAS, ARIZONA, A.D. 500 - 1000
MEAN = 1.00, SD. .432



HOPI MESAS, ARIZONA, A.D. 1000 - 1500
MEAN = 1.00, SD. .432



HOPI MESAS, ARIZONA, A.D. 1500 - 1971
MEAN = 1.00, SD. .432

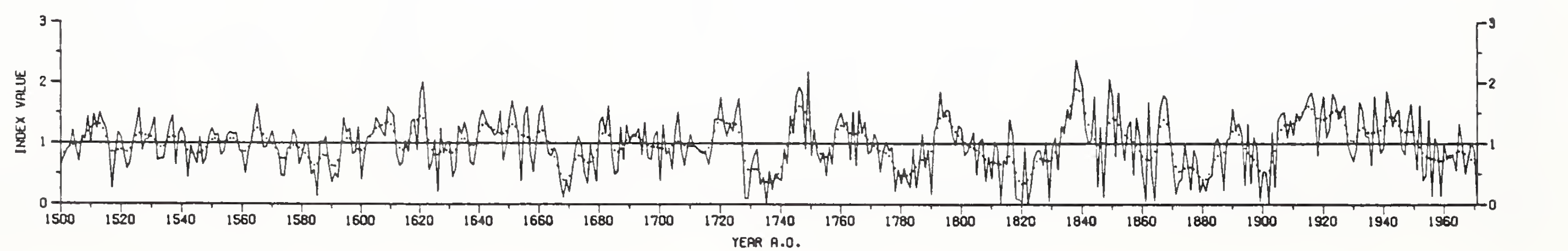


Figure 28. Hopi Mesa chronology.

values considerably below the mean indicate warm/dry conditions. Values greater and less than two standard deviations from the mean generally indicate anomalously wet and dry periods.

The appropriate standard deviation cutoff is more of a specific anthropological question than a dendrochronological question. Although a $\pm$ 2 standard deviation cutoff indicates statistical significance at the 0.05 level, what it means in terms of human ecology is an altogether different question; perhaps 1.0 or 1.5 standard deviations is a more realistic value. Dean et al. (1985:543) suggested that dendroclimatic variability indicative of high and low effective moisture may be associated with behavioral responses from human populations. These responses include expansion, contraction, or change in field location, diversification of field locations, water control devices, and changes in dependence on agricultural foods relative to wild foods.

Jorde (1977) found that periods of increased tree-ring index variability between A.D. 750 and 1049 were associated with increased development of storage facilities, irrigation structures, and aggregation along permanent drainages by about A.D. 1000. These features are viewed as attempts to buffer, or have some control over, high frequency environmental variability.

In reviewing a study by Plog (1983), Dean et al. (1985) hypothesized that periods of high spatial variability in paleoclimatic conditions are associated with subsistence stress on populations, which interact and exchange with other groups as a viable means of offsetting local production shortfalls. During times of high spatial variability in climate, different groups are viewed as experiencing different degrees and types of subsistence stress. During times of low spatial variability similar conditions prevail over a wide area and interaction and exchange are viewed as less likely means for alleviating local population-resource imbalances. A detailed consideration of spatial variability among tree-ring series on the Arizona Strip would require a denser network of sites than the few chronologies included in expanded 25 station set.

Dendrohydrology and the Arizona Strip

Dendrohydrological studies are also an integral aspect of paleoclimatic reconstruction in the southern Colorado Plateau region. The feasibility of augmenting runoff records using tree-ring data, and the technical considerations involved, are explored by Stockton (1971, 1975, 1976), Stockton and Fritts (1971, 1973), Stockton and Boggess (1980), and Stockton and Jacoby (1976).

Larson (1986a, 1986b) has recently undertaken a detailed cultural ecological study of cultural change among the Virgin Branch Anasazi. Some of the spatial area in his study lies in the northwestern part of the Arizona Strip. A portion of the research involves dendrohydrological reconstruction of flow on the Virgin River, using a previously established bristlecone pine chronology from Mt. Charleston, Nevada, near Las Vegas. According to Larson's interpretation, this reconstruction suggests drought conditions along the Virgin River between A.D. 966 and 1015, moderating conditions between A.D. 1020 to 1060, very wet conditions between A.D. 1060 and 1120, and finally, drought conditions returning between A.D. 1120 and 1150. Larson then correlates these climatic conditions with cultural developments.

The problem with Larson's argument from a paleoenvironmental perspective is that the Mt. Charleston reconstruction must be regarded with a great deal of caution. It is based on a tree-ring chronology of dubious quality for making quantitative paleoclimatic reconstructions. The problem is not peculiar to the Mt. Charleston chronology, but is common in other bristlecone chronologies from the Cedar Breaks and Bryce Canyon region (e.g. Drew 1972). The crux of the problem lies in the fact that the chronology has very few specimens prior to about A.D. 1500, hence the tree-ring index values are unreliable because of their large standard errors. Thus, even if a satisfactory and verifiable calibration equation could be produced during the most recent years relating tree-ring index variability to hydrological or climatological changes, its application to a tree-ring series based on a few specimens is risky at best because of the large error associated with the yearly tree-ring index values. Secondly, the large amount of autocorrelation in the Mt. Charleston tree-ring chronology leads to problems in establishing a reliable relationship between it and any climatic variables (Graybill 1985, Fritts 1976). Again, these are problems that are common to high elevation bristlecone and limber pine chronologies in the Rocky Mountain and Great Basin regions. A great deal of research is currently centered on unraveling the manner in which these trees respond to temperature and climate, and on determining the most effective techniques for extracting any climatic information that may be present in the chronologies (e.g., Graybill 1986). Unfortunately, until these relationships are understood, Larson's correlation between environmental conditions and cultural development must be considered premature.

Palynology

Palynological analyses provide information about environmental variability on a lower frequency than tree-ring analyses. The exact type of frequency information available depends on how accurately and precisely the pollen bearing strata are dated and as previously mentioned, on the number of dates available. Ceramic dating, dendrochronology, and radiometric dating generally provide the chronometric controls necessary for low frequency palynological reconstructions.

Analyses of pollen from archaeological and alluvial contexts on Black Mesa (Euler et al. 1979; Hevly 1981), and the Hay Hollow Valley (Bohrer 1968, 1972; Dickey 1971; Hevly 1981) have resulted in a portrayal of effective moisture trends for the southern Colorado Plateaus. This research is probably the most applicable to the Arizona Strip because of its geographical proximity, the extremely high temporal resolution, and the wealth of complimentary dendrochronological, alluvial geochronological, and archaeological studies. Figure 29, drawn from Dean et al. (1985:541), shows the effective moisture curve from Hay Hollow from the A.D. 200s to 1300s (solid line), which is based on changes in pinyon and ponderosa pollen. The superimposed dashed curve shows another curve from Hay Hollow based on the ratio of pine to juniper pollen. The second dashed line (lower one in the figure) covering the A.D. 800s to 1800s is based on pine/juniper proportions from Black Mesa.

The Hay Hollow small-versus-large pine pollen record shows that the period from about A.D. 300 to 500 was one of relatively low effective moisture. In turn it was followed by another 200 year period of high effective moisture ending about A.D. 700. The succeeding interval of years to about A.D. 1000 was characterized by low effective moisture. The following 200 years, up to about A.D. 1200 suggest higher effective moisture which was followed by arid conditions to the end of the palynological record at about A.D. 1300. The ratio of pine-to-juniper pollen shows a higher frequency record, suggesting more short term variations in effective moisture. Additional evidence for variability in effective moisture is derived from the Black Mesa pine/juniper ratio, which covers the interval of years from about A.D. 800 to the present.

Higher effective moisture is indicated for the early portion of the A.D. 900s, the mid-1000s, the early 1100s, the early 1200s, the late 1300s, the early 1600s, and the mid-1700s. The years between these periods are ostensibly characterized by lower effective moisture.

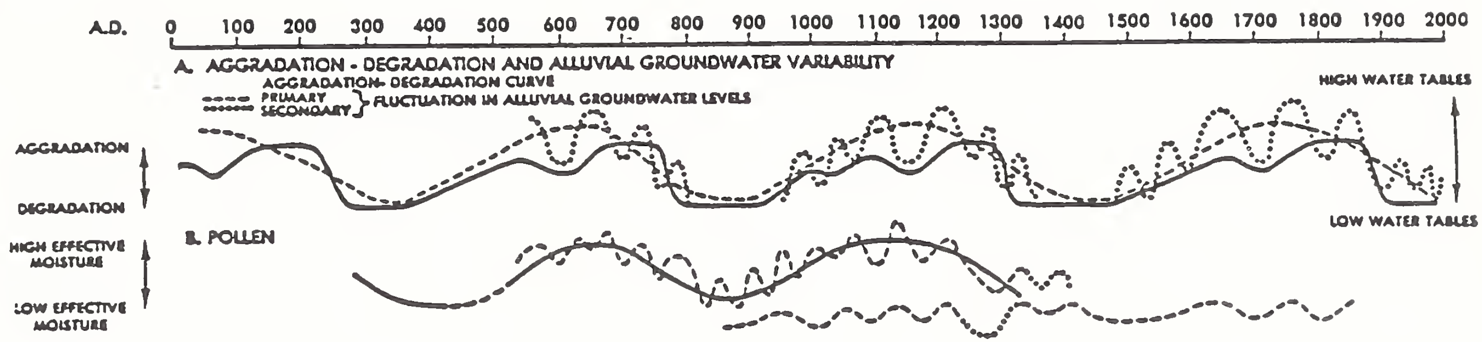


Figure 29. Relative changes in Aggradation-Degradation and Effective Moisture on the Southern Colorado Plateaus. The superimposed dashed line is derived from the ratio of pine to juniper pollen at the same location, and the lower dashed line is the pine/juniper ratio from Black Mesa. (Figure from Dean et al. 1985:541).

Alluvial Geochronology

Chronostratigraphic studies of well dated alluvial sediments on the Colorado Plateau provide information on low frequency environmental variability. Much of this information comes from the Black Mesa area in northeastern Arizona (Euler et al. 1979; Karlstrom 1978; Karlstrom et al. 1976). Other studies of alluvium dated with relatively high resolution include the research at Chaco Canyon by Hall (1977) and Love (1980), work in the Navajo Reservoir District by Schoenwetter and Eddy (1964), and recent Effective Moisture on the Southern Colorado Plateaus. The solid line represents general deposition and erosion along drainages, the dashed line reflects major trends in alluvial groundwater levels, and the dotted line shows secondary variability in the hydrologic cycle. The solid curve is based on the amount of small versus large pine pollen from Hay Hollow Valley, the general correspondence among all of these records indicates that the Black Mesa sequence is generally representative of hydrological history throughout the region (Dean et al. 1985; Euler et al. 1979), while realizing that future intraregional variability may yet remain to be defined.

The research on Black Mesa revealed episodes of erosion and deposition separated by periods of relative stability and soil formation on floodplain terrace surfaces. Euler et al. (1979:1097) suggested that alluvial deposition occurs during intervals of increased rainfall/runoff, rising regional water tables, and wetter climatic conditions. Nondepositional intervals, defined by soils and unconformities, occur during periods of lower rainfall/runoff, lower regional water tables, and drier climate. This interpretive position agrees with evidence obtained from tree rings and pollen.

Major arroyo-cutting episodes are thus seen to occur during the transition from wet to dry intervals or during periods of declining water tables. This explanation is one of a number of models that have been offered to account for the "arroyo problem" in the Southwest (Graf 1983:279-302). The arroyo problem centers on explanations of what factors caused the development of arroyos, not only during the latter part of the nineteenth century, but also prehistorically. The model described above is not necessarily incompatible with the hypothesis offered by Schoenwetter and Eddy (1964) that arroyo cutting results from a shift from winter to summer dominant precipitation. No conclusive paleoenvironmental evidence supports it, however, and some evidence that has been mentioned in the palynological section appears to contradict it.

Relative changes in hydrologic and cut/fill episodes are shown in Figure 29, which is part of a figure from Dean et al. (1985:541). The solid line represents the general changes in the deposition (positive slope) and erosion (negative slope) of alluvial deposits. Major decreases are also associated with soil development on terrace surfaces, while minor dips represent times of surface stability and soil formation. Superimposed on the solid line are fluctuations in groundwater levels. As Dean notes, the curves accurately indicate relative changes in groundwater levels and soil deposition.

Northeast of the study area in south-central Utah, the late Holocene flood history and associated channel changes of the Escalante River have been investigated by Webb (1985). Flood deposits at eight sites in the canyon indicate that the frequency of large floods was at a maximum about 1100 to 900 years BP. The largest flood occurred about 1000 to 900 years BP and was seven times the largest discharge recorded at a gaging station. Upstream alluvial channel changes were related to flood-frequency changes. Alluvial stratigraphy covering the past 1600 years indicates that after 1100 years BP, when there was an increased frequency of large floods, a marshy floodplain was converted to a dry meadow, and an arroyo 24 meters wide and 2.5 meters deep formed. The arroyo filled with sediments between 500 and 400 years BP, and a smaller channel formed and persisted until the latter part of the nineteenth century. Between 1909 and 1940, floods transformed the small channel into an arroyo up to 100 meters wide and 17 meters deep.

Webb (1985:163-172) indicates the cause for flood-frequency and subsequent channel changes on the Escalante River is complicated. Two hypotheses offered are that land use practices induced changes in watershed and floodplain conditions, while a subtle climatic shift increased the amount of summer precipitation and storm intensity.

Other explanations have been offered for the problem of arroyo formation in the Escalante region. Boison's (1983) study of the stratigraphy on three tributaries of the Escalante River concluded that there was no regional cause. Boison and Patton (1985) found that the formation of terraces in Coyote Gulch, an Escalante River tributary, was instigated by landslide-generated pulses of sediment followed by sediment flushing.

Nearby, in the Paria River drainage, Hereford (1986) examined the modern alluvial history in light of the development of arroyos in the Southwest. He found that stream channels were eroded and partially refilled between 1883 and 1980. The erosion began on a basin-wide scale in 1883, with channels fully entrenched a mere seven years later. Photographs of the drainage basin show that between 1918 and 1940 the channels were wide and deep and without floodplains. Aggradation began in the 1940s, and floodplains developed by vertical accretion. High peak flood discharges were associated with erosion and low flood discharges with aggradation. Hereford noted that the erosional or aggradational tendencies of the streams were primarily determined by peak-flood discharge, which is controlled by precipitation.

Graf (1983) pointed out that a widely accepted and well integrated theory for arroyo formation has not been developed because of limited testing, lack of sediment data, and lack of long-term historical records. In reviewing the progress of research geomorphology and arroyo formation, he reviews the limited number of explanations that have emerged from the immense body of literature, especially that from the southwestern United States. These include, but are not limited to, grazing, climatic conditions, and catastrophic events. The summaries previously presented indicate that no real consensus has been formed about the causes of arroyo formation on the Colorado Plateaus.

Packrat Midden Analysis

Studies of fossil packrat middens provide evidence of low frequency changes in the environment over the past 12,000 years in areas surrounding the Arizona Strip. The middens are usually found in rock shelters and caves, where they are protected from the eroding effects of wind and water. The middens represent the part of the packrat's den where debris and waste are compacted and cemented into hardened masses by urination and trampling (Van Devender and Mead 1976:16). The materials in the midden represent food items and objects used for its construction -- plants generally from less than 100 meters away. When the middens are deposited in dry shelters, they can be preserved for very long periods of time, and the plant fossils recovered from the deposits give excellent records of local plant communities. The assemblages of plants preserved in the middens can be placed in time by radiocarbon dating, enabling inferences to be made about past changes in plant communities. When vegetation and floristic changes can be linked to climatic conditions, the middens can provide a very long record of past climatic changes.

Betancourt (1984) analyzed plant macrofossils from packrat middens in Allen Canyon Cave (2,195 m elevation) and Fishmouth Cave (1,585 m elevation), both in southeastern Utah, to outline the development of modern plant zonation from the late Wisconsin. By using long temporal sequences from individual locations, changes in the floristic composition of areas of less than one hectare can be sporadically defined for tens of millennia. At the higher elevation site, Allen Canyon Cave, Engelmann spruce-alpine fir forest was replaced by pinyon-juniper woodland on exposed ridgetops and on cliffsides by stands of Douglas-fir, ponderosa pine, and aspen. The more xerophytic woodland plants such as pinyon, plains prickly pear, and narrowleaf yucca arrived in the middle Holocene, between 7,200 and 3,400 years B.P..

At Fishmouth Cave, the lower elevation, blue spruce, limber pine, Douglas-fir, and dwarf and Rocky Mountain junipers in late Wisconsin samples were replaced by Utah juniper, typically found on warmer and drier sites. This assemblage indicates a minimum lowering of at least 850 meters for blue spruce, limber pine, and dwarf juniper. The late Wisconsin at this location also shows a disharmonious association of the subalpine conifers growing along side Mormon tea, narrowleaf yucca, and plains prickly pear. Apparently this anomaly is due to the absence of pinyon pines and ponderosa from the Colorado Plateau in the late Wisconsin. The absence of competition from these species allowed the subalpine conifers to expand to lower elevations and mix with the xerophytic plants presently found as understory in pinyon-juniper and ponderosa woodlands. Betancourt (1984) estimates a 3 to $4^{o}C$ decrease from present mean annual temperatures during the late Wisconsin and from 35 to 60 percent more rainfall than present. In more mountainous terrain, a temperature depression of $5^{o}C$ and a rainfall increase up to 120 percent over modern conditions is suggested.

Modern distributions of pinyon and juniper species and their associated plants occupy a regional platform in the Four Corners region with a regional base level of about 1,500 m, or just less than 5,000 feet. During the late Wisconsin this was roughly their upper limit as they expanded into desert lowlands (Betancourt 1987). In the Sonoran Desert, pinyons reached elevations of 460 m, and junipers got down to about 240 m. By about 10,000 to 8,000 B.P., Rocky Mountain pinyon migrated onto the Colorado Plateau, not reaching its highest elevation sites until 6,000 to 4,000 B.P. This delay may have been due to the presence of an expanded ponderosa pine zone. This ponderosa pine transition zone now separates the pinyon-juniper zone from the mixed conifer and subalpine forests. During this time, altitudinal displacements occurred more rapidly than latitudinal movement, so the changes were time transgressive.

On the Colorado Plateau, limber pine (Pinus flexilis), blue spruce (Picea pungens), Douglas-fir, and Rocky Mountain juniper remained at elevations of 1,585 to 1,910 m until about 10,000 B.P. (Betancourt and Van Devender 1984; Betancourt 1984). Single needle pinyon did not migrate across the Great Basin towards the Southwest until after 6,500 B.P. Thompson and Hattori (1983) suggested this delay may have hinged on the development of winter inversions, summer rainfall, and warmer mid-Holocene summer temperatures. Betancourt (1987) also noted that the distribution of single needle pinyon may have been due in part to its greater insular distribution in the Great Basin, compared to Rocky Mountain pinyon, which is more common in the southern Rockies and the Colorado Plateaus.

Spaulding (1983, 1985) has summarized the midden evidence for environmental change since the late Wisconsin in the Mohave Desert, at the western end of the Strip. Until the discovery of six older macrofossil assemblages lacking arboreal species and dating to almost 15,000 B.P., records of desert scrub vegetation were less than 10,500 years old. The older middens demonstrate that although xerophytic conifer woodland was widespread in desert habitats during the late Wisconsin and early Holocene, the development of desert vegetation was not delayed until the middle Holocene. Instead, a regional mosaic of desert scrub and woodland existed at altitudes below 1,000 m in the Mohave Desert during the last part of the late Wisconsin. This mosaic probably resulted from spatial and temporal changes in soil and climatic conditions. Desertscrub assemblages of early Holocene age (10,000 to 8,000 years B.P.) have also been recovered from most of these locations, as have midden records of juniper woodland.

Perhaps one of the most relevant applications of the packrat midden analysis in the Arizona Strip region has to do with the question of presettlement conditions and postsettlement invasions. The debate about the relative influences of climate, grazing, and fire suppression with respect to pinyon-juniper invasions is as controversial as the arroyo formation problem. Mehringer and Wigand (1987) demonstrated that the recent invasion of western juniper (Juniperus occidentalis) in the northwestern Great Basin is no greater than its changes over the past several thousand years. It is suggested that the historic pinyon-juniper invasion may simply be part of an ongoing process encompassing the past several thousand years. Davis (1987) makes a strong argument in favor of this point for central Arizona using a palynological analysis of Peck's Lake sediments. These studies have resulted in questions about the real stability of presettlement vegetation and the uniqueness of the recent invasions. Are the present conditions really due to overgrazing and fire suppression, and could they also reflect the woodlands resilience from historic and prehistoric fuelcutting? It is unfortunate that little Holocene paleobotanical data have been collected near the woodland/grassland boundaries in the Sonoran, Mohave, and Chihuahuan deserts and other areas in the Great Basin and Colorado Plateaus.

A GENERAL HISTORY OF PALEOENVIRONMENTAL CHANGE ON THE ARIZONA STRIP

The data presented represent a continuous but somewhat patchy record of environmental and climatic changes occurring over the past 12,000 years, with unequal representation of changes at different frequencies. For the Wisconsin (12,000 to 10,000 years ago), a southward displacement of the polar jet stream and the winter air mass boundary described by Mitchell (1976) has been suggested. Betancourt (1984) noted that such a displacement has been proposed on the basis of packrat midden analyses, modern plant distributions, and computerized models of the general atmospheric-circulation. In the Arizona Strip region, a southerly displacement of the jet stream, and hence the mid-latitude storm track, would probably be associated with increased winter precipitation, decreased summer precipitation and cooler summer temperatures, and a higher frequency of spring freezes than today. In this scenario, large decreases in winter temperature would have been prevented by the presence of ice sheets in North America, which would have blocked low-level incursions of Arctic air. Under these conditions mild winters would be expected.

The early Holocene (ca: 10,000 to 8,000 years ago) on the Colorado Plateaus appears to have been a time of rapid vegetational change. Based on the packrat evidence, Betancourt (1984:29) notes that by 10,000 B.P. blue spruce and Dwarf juniper disappear from the sequence, followed shortly thereafter by limber pine and Rocky Mountain juniper. The change toward modern flora occurred between 10,000 and 7,200 B.P. in southeastern Utah at Fishmouth and Allen Canyon caves and between 9,500 and 8,300 B.P. in the lower elevational Chaco Canyon sequence. The new arrivals include Ponderosa pine, Gamble oak, and one-seed juniper. Pinyon pine (P. edulis) was a somewhat later arrival in its mid-elevational range between 10,000 and 8,000 B.P., only expanding to its present limits during the middle and late Holocene.

The climatic scenario associated with the Pleistocene to Holocene changes is a northward displacement of the polar jet stream and mid latitude storm track. The return of plants displaced to the south during the Pleistocene and the upward migration of subalpine and upper montane species are interpreted to mean increased summer and average annual temperatures, a decreased frequency of spring freezes, and a shift from an overall winter dominant to a summer dominant rainfall pattern or a split summer-winter pattern, depending on the region. The present summer monsoon boundary evidently became established between 10,000 and 8,000 B.P, but the modern vegetation was not fully in place until about 2,000 to 3,000 years ago.

For the period between A.D. 1 and 500, the only indicators of climatic change are the alluvial geochronological and palynological records. The alluvial record, which begins at about A.D. 1, suggests that relatively stable alluvial conditions prevailed prior to A.D. 100, followed by a period of aggradation and high water tables in major drainages between A.D. 100 and the early 200s. From the early 200s until about A.D. 550, degradation and lowered water tables are suggested. The pollen record, which starts between A.D. 200 and 300, is consistent with the geomorphic evidence, indicating decreased effective moisture from the mid-200s until about A.D. 500.

Alluvial, palynological, and dendrochronological data are present for the period between A.D. 500 to 1000. From the early 500s through the early 600s, a period of alluvial degradation is suggested, followed by relative stability until about A.D. 700. The late 700s through the mid-900s are marked by alluvial degradation and lowered water tables. Beginning in the mid-900s, there apparently was a change toward aggradational conditions and higher water tables. The palynological record from Hay Hollow suggests a general increase in effective moisture from about A.D. 500 to about 700, followed by a decrease that reaches a minimum about the mid-800s. From that point to about A.D. 1100, a general increase in effective moisture is suggested. The pine-to-juniper ratios from Hay Hollow and Black Mesa provide evidence of secondary fluctuations in effective moisture, the former from about A.D. 500 onward and the latter from the mid-800s onward.

The tree ring record from the Hopi Mesas allows us to bring the low frequency trends into sharp focus. Droughts are indicated for the years (approximately) A.D. 510 to 520, 550 to 570, 700 to about 717, the early 820s to about 830, and the decade from 900 to 910. Periods of cool moist conditions favorable for tree-growth are indicated for the years A.D. 500 to 510, 520 to 550, 570 to the early 580s, the mid-630s to the early 640s, the early 680s to the mid-690s, the decade centered on 730, and a general upward trend from about 750 to about 805. The years from A.D. 880 to about 900, the mid-920s, and the mid-980s are also characterized by above average effective moisture.

For the period from about A.D. 1000 to about 1200, the chronostratigraphic record suggests generally higher water tables. Episodes of alluvial deposition, separated by intervals of erosion, are suggested for the late A.D. 900s, the 1030s, and the years around 1100 and 1200. A period of lower water tables and alluvial degradation occurs in the late 1200s to the 1500s and later. The palynological record in general, and in terms of secondary fluctuations, follows the alluvial reconstruction. Increased effective moisture from about A.D. 1000 to 1200 is followed by a return to drought conditions through the early 1400s, when the Hay Hollow record ends.

The tree-ring record for A.D. 1000 to 1500 shows that the years from A.D. 1000 to 1200 were some of the most stable in the entire record in terms of dendroclimatic variability. Periods of cooler-moister conditions are suggested for the late A.D. 1040s to the mid-1060s, from 1110 to 1120, and from the mid-1190s to about 1210. Although there are particular years and groups of years of drought conditions, no periods of prolonged drought are indicated.

The following 300 years, from A.D. 1200 to 1500, evidence a number of droughts and groups of years with cooler and moister conditions. There are also intervals of years with pronounced intra-annual changes. Warm and dry conditions are apparent from about A.D. 1210 to the late 1220s, the mid-1260s, the late 1270s to about 1300, the early 1360s, the late 1430s, most of the decade from 1440 to 1450, the late 1450s to the mid-1460s, and the early 1470s. The period from about A.D. 1230 to about 1300 was also characterized by considerable high frequency variability, while the years from 1300 to the mid-1360s, and from the early 1420s to 1500 are characterized by increased low frequency variability in the tree-ring record.

The post-A.D. 1500 alluvial record shows a change from lowered water tables at 1500, which increased to a maximum high in the mid-1700s, only to return to lower levels into the present century. There is also a trend toward aggradational conditions in major drainages to about the mid-A.D. 1800s, at which point a pronounced change to degradational conditions occurs. Superimposed on this general trend are smaller depositional pulses in the late A.D. 1400s, the mid-1500s, and the middle 1600s, 1700s and 1800s. These aggradational intervals were separated by brief returns to degradational conditions.

The palynological record from Black Mesa extends to the middle part of the last century. It reveals that effective moisture levels tend to parallel the alluvial record. The aggradational intervals of the mid-A.D. 1600s, mid-1700s, and early 1800s are associated with increases in effective moisture.

The Hopi Mesas tree-ring record shows some major droughts and above average moisture conditions. Extended dry periods are indicated between A.D. 1570 and the early 1580s, the mid-1660s to about 1680, the mid-1720s to the early 1740s, the late 1770s to 1790, the early 1800s to about 1830, and the 1870s to the mid-1880s. A decadal drought is also centered on the turn of the present century, and there is a tendency toward warmer and drier conditions from the early 1950s through the 1960s. Cooler and moister conditions associated with above average index values occur in the late A.D. 1520s, the mid-1560s, from about 1605 to the early 1620s, 1640 to the early 1660s, the years around 1720, the early 1740s to the late 1760s, 1790 to 1800, the mid-1830s to about 1870, and an extended period of above average conditions from about 1905 through the late 1940s. The period from about A.D. 1700 to the present is also characterized by considerable low frequency variability.

AGRICULTURE

Agriculture is a risky practice over large areas of the Arizona Strip. This is especially true for areas located away from sources of permanent water, such as the Virgin, Paria, or Colorado Rivers. The importance of a permanent water source cannot be overemphasized, especially in the northwestern and the far northeastern portions of the study area. Both of these areas have higher temperatures and longer frost-free periods than the remainder of the Arizona Strip, and would probably have been reasonable sites for agriculture.

Several studies have specified the relevant attributes of Puebloan agriculture (e.g. Hack 1942, Ford 1972), which are summarized by Cordell and Upham (1983). As Cordell and Upham note, there are no modern analogs for all of the varieties of prehistoric crops cultivated in the Southwest. The most notable plant in this regard is maize (Zea mays), which is characterized by genetic diversity and plasticity. For this reason, the specific climatic and soil requirements are unknown, although water and soil nutrients are probably the most limiting factors. It is also possible that native "wild" species were cultivated, or at least encouraged. Cordell and Upham (1983) note that native species are rarely considered in discussions of Southwestern agriculture, although they were probably prime determinants of some site locations.

One information source about the potential variability that might have been present prehistorically is a consideration of the types of variability present today in crops grown by Native Americans. Native Seeds/SEARCH is a nonprofit, seed conservation organization involved in collection, research, and education regarding traditional native crops and their wild relatives in the U.S. Southwest and northern Mexico. This organization has amassed seed from many domesticates and wild varieties growing in a diverse range of environmental conditions. The many modern varieties serve to illustrate the genetic plasticity of many of the species grown or collected prehistorically. Other publications discuss the methods and species suited to semi-arid areas of the Four Corners region (e.g., Weinberg n.d.), or more desert regions at lower elevations (Nabhan 1985, Nabhan and Mirocha 1986), or specific crops such as corn (e.g. Native Seeds/SEARCH n.d.a., n.d.b.).

For agriculture, not only is the amount of moisture received important, but its timing is also crucial. First, sufficient moisture must be available for germination during the spring or summer, depending on when crops are planted. Spring germination is a problem in many portions of the Arizona Strip, for it is a time of minimal rainfall. It is a problem that could possibly be circumvented if fields were located in areas that receive snow during the winter, but which have warm spring temperatures and soils with good moisture retention characteristics. These characteristics are present in the Paria Plateau and Mount Trumbull regions, which not surprisingly have a great many puebloan sites. Additional moisture is also required during the growing season, especially during the corn tasseling/silking period about two months after germination (Cordell and Upham 1983), and at the end of the growing season, sometime near the end of the fourth month. Although modern hybrid maize requires a tremendous amount of moisture (ca: 20 in.) during the growing season, modern Indian varieties from the southwest have been identified that require about only one third this amount (Native Seeds/SEARCH 1988). Lack of moisture during the tassling/silking period can result in yields only 25 percent of normal, or less. Lack of moisture at the end of the growing season is not as critical but can result in crop losses of about 20 percent. If spring precipitation and residual winter soil moisture are inadequate for crop germination, successful cultivation may be dependent on summer monsoon rains.

Present day Native Americans on the Colorado Plateau and at lower desert elevations in the southwest have many types of corn, used for different purposes, that are reasonably drought resistant and able to cope to some extent with alkaline soil. For example, flour types are soft, ground for cornmeal, or roasted; sweet corn is baked or fresh boiled; flint corn is hard kerneled and normally prepared by grinding; dent corn is used for roasting, made into tortillas, and used in the preparation of other dishes; while popcorn can be popped or toasted for grinding. Corn has high fertilizer requirements and is best planted in combination with beans.

The Hopi have several types of flour corn that can be grown under a variety of conditions (Native Seeds/SEARCH 1988). Hopi Blue corn is planted deep in fine sandy soil and irrigated, while the Chin Mark variety, said to come from the Havasupai of the Grand Canyon, is also irrigated. Other varieties such as Greasy Hair and Hominy are dry farmed and grown in sand dunes, respectively. The diversity in flour corn can be further illustrated by reference to the Mojave, who have short-stalked, fast-growing (ca. 60 days), desert-adapted white and sweet corn. A white corn grown at Taos Pueblo is adapted to high elevations, as are many of the varieties (some with a three month growing season) grown by the Tarahumaras in the mountains of northern Mexico. The Hopis also have a cold tolerant variety (Hopi Early) that is planted in early spring.

Less information is available on varieties and distribution of prehistoric beans. It is known that modern varieties of beans (Phaseolus vulgaris) cultivated by Native Americans today in the southwest are planted after the danger of frost is past, because they require warm, well drained soils and are more photosensitive during germination than maize. Beans are the traditional protein complement to corn, come in many tastes and colors, and are also rich in minerals and fiber. They may fix nitrogen if bacteria are present in the soil. Many varieties of beans are dry farmed in the Four Corners region in the pinyon-juniper zone (Native Seeds/SEARCH 1988). Hopi Black beans are dry farmed, and are prolific when irrigated at oak-woodland zone elevations, while Hopi Yellow beans are a dry farmed staple. The Tarahumaras in the mountains of northern Mexico have many varieties that grow in 90 to 120 days in many different environmental settings, from arid areas with thin rocky soil to canyon bottoms to high mountain valleys.

Squash (Cucurbita spp.) is even hardier than beans or maize, and responds favorably to large amounts of water. The flowers, fruits, and seeds are all edible, and the seeds are rich in lysine and oil. Many different varieties (Native Seeds/SEARCH n.d.b.) are presently grown by Native Americans at elevations ranging from low desert to the mountains. All varieties can be eaten as summer squash when they are small and immature.

In addition to soil moisture, the length of the growing season is a potential problem on the Arizona Strip. Even for varieties of Indian corn adapted to local Southwestern growing conditions, at least two to three frost-free are required. A longer than normal growing season may be required if moisture deficiency is also a problem (Hack 1942). Modern varieties of corn have less resistance to low temperatures than beans. Corn is generally considered to have a low resistance to frost, while beans are fairly resistant. Corn can stand two to three degrees centigrade below freezing during germination, one to two during flowering, and two to three during fruiting. Beans can withstand five to six degrees below freezing during germination, two to three during flowering, and three to four during fruiting.

There is considerable variability on the Arizona Strip in seasonal moisture availability, temperature regimes, and the length of time between freezing temperatures. The longest growing seasons are present in the far western part of the Arizona Strip, while the higher areas over the remainder of the Arizona Strip may have freezing temperatures into May and as early as late September. Even in the vicinity of Jacob Lake, however, the growing season runs from mid-May to late September. On a long-term basis the growing season over most of the Strip is long enough. Establishment of agriculture as a viable subsistence activity would, however, require balancing the increased moisture availability associated with higher elevations against the decreased temperatures and potential shortened growing season, even in areas where soils have good moisture retention capabilities. The potential problem in terms of temperature is with mean minimum as opposed to mean maximum. At elevations over about 5,000 feet mean minimum temperatures may be less than optimum. Ideal crop growing areas on the strip would be characterized by high winter precipitation and cool winter temperatures, spring precipitation in any form and warm temperatures, and high summer rainfall and moderate temperatures. High summer rainfall can also pose problems if it arrives in the form of torrential thunderstorms, which can be devastating to crops.

The highest winter precipitation on the Arizona Strip is received on the Kaibab Plateau and in other high elevation areas, such as Mount Trumbull. The coolest winter temperatures are recorded on the Kaibab Plateau and in the southeastern part of the study area bounded by the Colorado River. The warmest temperatures occur in the northwestern part of the Arizona Strip and on the Paria Plateau.

During the spring, moisture is scarce over the Arizona Strip. The western area is warmer than the east, with the exception of the Paria Plateau, which has warmer temperatures than the surrounding area, especially the Kaibab Plateau. The best areas for agriculture, in terms of moisture availability from nonpermanent sources during the spring and early summer, would be higher elevations, the Kaibab Plateau, and ephemeral streams draining higher elevations.

During the summer, the northwestern and northeastern parts of the Arizona Strip have the highest temperatures, while the central and southeastern areas are relatively cooler. It is important to note that the areas with permanent water are also in the northwest and northeastern areas. During July and August, more precipitation is received in the eastern half of the Arizona Strip. By September the summer monsoon has retreated to the southeast, and the precipitation received over the whole area is fairly uniform and small quantity. The best locations for agriculture in terms of moisture availability would have been the northwestern and northeastern parts of the Arizona Strip and higher elevations in the central part where temperatures are cooler.

Consideration of monthly precipitation and temperature variables alone shows that much of the Arizona Strip would probably have been marginal for agriculture. Field selection in marginal locations could help to mitigate the adverse effects of moisture shortages. These include field location at higher elevations, on flat areas and on north-facing slopes at lower elevations, along drainages, and on soils with good moisture retention characteristics. Technological facilities such as water and soil control features, increasingly common in the Southwest after about A.D. 900, can also be used to buffer high frequency changes in the environment. Over much of the Arizona Strip, however, agriculture as a sustainable producer must have been supplemented by considerable reliance on hunting and gathering of wild plants.

Thus far agricultural potential has been considered from the basis of the modern climate. Combining these observations with the paleoclimatic evidence strongly reinforces the tenuous nature of agricultural practices on the Arizona Strip. Perhaps the most striking aspect of the Hopi Mesa tree-ring chronology (Figure 28) is the instability of the graph. Decades of drought are followed by decades of well above average precipitation. One has to assume that such variation characterizes the seasonal precipitation pattern as well.

The Hopi Mesa chronology also illustrates a fundamental point crucial to understanding Formative period cultural development. As will be discussed in Chapter 4, a popular argument for the large increase in site numbers during Pueblo II times (A.D. 1000-1150) is that this was a generally wet period that allowed the expansion or intensification of agricultural practices into large portions of the Arizona Strip that had previously been little used. The chronology suggests, however, that the annual precipitation levels during Pueblo II were not significantly different from those that occurred during the preceding Pueblo I (A.D. 800-1000) or during most of the Basketmaker III (from A.D. 600 on) periods.

Researchers must recognize that a general summary of the tree-ring record does not really present an adequate portrayal of the time series. For example, some of the drought periods are punctuated by brief returns to average and above average conditions, and some moist intervals are interrupted by returns to normal and drought conditions. A particular period of interest to the individual scientist should be examined not only to determine extended periods above and below the mean conditions, but also changes in frequency from high to low index values and vice-versa, and the years that exceed particular threshold values, such as + or - 1.5 or 2.0 standard deviations. This assumes that the proxy tree-ring record can be linked to events of importance to the particular sociocultural system being investigated.

Future paleoclimatic investigations can aid in developing these links. Further work in tree-ring densities may lead to an understanding of past seasonal variation in temperature. These data would allow us to discuss in a much more rigorous fashion the likelihood of any given harvest in the past being a good or bad one. Once the potential contribution to the diet from agriculture is established we can examine the actual importance of other subsistence practices and develop the links between changing subsistence strategies and cultural development.

CHAPTER 3

PREVIOUS RESEARCH

Helen C. Fairley

The prehistory and aboriginal history of the Arizona Strip remains one of the more poorly understood topics in Southwestern archaeology. Although a substantial number of archaeological and ethnographic studies have been conducted in the area over the past 80 years, many have never been reported in the published literature. With a few notable exceptions, most of the studies that have been published are relatively brief and lacking in detail. Furthermore, the majority of archaeological data from the Arizona Strip derive from relatively short-term projects conducted by individuals whose primary professional interests lay outside the boundaries of the Arizona Strip. These factors have contributed to the disjointed quality of the currently available data base. Despite these limitations, there is a wealth of information to be gleaned from the existing published literature, unpublished fieldnotes, cultural resource management reports and institutional site files relating to this area.

This chapter reviews previous research undertaken in the Arizona Strip under two basic divisions: archaeology and ethnography/ethnohistory. The archaeology section is subdivided temporally according to the main thrust of research during each period: Exploratory Studies (ca. 1776 to 1920), Descriptive Studies (ca. 1921 to 1965), and Cultural Resource Management Studies (ca. 1966 to the present). Ethnographic and ethnohistoric research is also discussed chronologically but is not subdivided.

The review involves two basic components: 1) a brief summary of each project on the strip, major contributions to the development of the cultural resource data base; and 2) a critical evaluation of the work in terms of current land management and research concerns. All major anthropological endeavors conducted in the Arizona Strip since the mid-1800s are reviewed (see also Appendix 1). A number of minor projects, mostly small-scale archaeological clearance surveys conducted for USFS and BLM cultural resource management purposes since the mid-1970s, are not discussed. To place the previous work on the Arizona Strip in perspective, brief discussions of research projects conducted in adjacent regions which have a direct bearing on the interpretation of cultural history within the project area, are also included.

Archaeological Research

Exploratory Studies: 1776-1920

The earliest references to archaeological remains in the Arizona Strip are recorded in the journals of trappers, traders, and explorers who passed through the region in route to other destinations during the late eighteenth and early nineteenth centuries. In the late autumn of 1776, a party of Spanish and Indian explorers led by the Franciscan friars Francisco Antanasio Dominguez and Silvestre Velez de Escalante traversed the Arizona Strip after abandoning their quest to find an overland route from Santa Fe, New Mexico, to the Spanish colonies in California (Bolton 1950; Warner and Chavez 1976). Escalante's journals provide brief but valuable information concerning the locations of various Paiute camps and trails and Paiute subsistence practices and material culture, as well as occasional references to abandoned campsites.

In 1826, Jedidiah Smith followed the Old Spanish Trail, formerly an aboriginal trade route, across the northwestern corner of Arizona into southeastern Nevada. Just across the Arizona border in what is now southeastern Nevada, Smith noted the presence of extensive aboriginal salt mines and associated artifacts near the junction of the Virgin and Muddy Rivers (Morgan 1953).

The earliest references to archaeological remains within the inner Grand Canyon are found in the journals made by John Wesley Powell and his men during their pioneering explorations on the Colorado River in 1869 and in 1871-1872 (Powell 1961; Dellenbaugh 1984; Darrah 1947; Darrah et al. 1948-1949; D. Fowler 1972). Powell was the first explorer to demonstrate a professional interest in the area's prehistoric inhabitants. In his original 1869 field journal, Powell attributed the ruins encountered along the river to Moqui (Hopi) Indians (Darrah 1947:130). In a later published version of the journal (considerably altered and enhanced from the original), he speculated that one well preserved ruin at the mouth of Bright Angel Creek was created by historic Hopi refugees escaping Spanish domination during the seventeenth and eighteenth centuries (Powell 1961:260).

Many of the ruins described by Powell and his men were relocated and recorded by archaeologists a century later (Fowler et al. 1969:9-18). In 1870, Edward Palmer of the Peabody Museum at Harvard visited southwestern Utah and the Arizona Strip, primarily for the purpose of gathering ethnobotanical data and examples of Southern Paiute material culture. Palmer returned to the area in 1875 in order to obtain additional ethnologic specimens and archaeological materials for the National Museum (Palmer 1876). His excavations at a large mound along the Santa Clara River outside of St. George, Utah, and at a cave in Johnson Canyon northeast of Kanab, constituted the first archaeological projects conducted in the vicinity of the Arizona Strip. Like most archaeology of this period, Palmer's excavation methods were designed to obtain museum specimens in an expedient manner, and therefore little attention was paid to the stratigraphic association of artifacts (Fowler and Matley 1978:22). Nevertheless, Palmer did publish a brief description of the architectural remains and burials encountered in the Santa Clara mound, along with a great deal of fanciful speculation regarding the lifestyle of the site's past inhabitants (Palmer 1876). The ceramic vessels recovered by Palmer were subsequently described and illustrated in Holmes' pioneering article on Southwestern pottery (Holmes 1886). Both Powell's and Palmer's collections have been recently reanalyzed according to current classificatory systems (Fowler and Matley 1978, 1979).

Although the reports of Palmer, Powell, and other early adventurers helped focus public attention on the prehistoric remains of the Arizona Strip, they contributed little to our overall understanding of regional prehistory. In fact, it was not until the second decade of the twentieth century that the first concerted effort to study the archaeological remains of the Arizona Strip and adjacent areas of southern Utah was initiated. In 1915, the first of six expeditions from the National Museum (Smithsonian Institution) was organized under the direction of Neil M. Judd (Judd 1926). During the first season, Judd visited sites in Antelope Valley, around Pipe Springs, and in the vicinity of Kanab. The 1916 and 1917 field seasons were devoted to excavations at Paragonah and other sites north of the Arizona state line. In 1918, Judd returned to the Arizona Strip, concentrating his attention on House Rock Valley and the Walhalla Plateau (Judd 1918, 1919). The 1919 season was spent in Cottonwood Canyon, west of Kanab, while the 1920 expedition focused on exploring the Paria Plateau and several northern tributary canyons of the Colorado River between House Rock Valley and the Kanab Plateau (Judd 1921); a brief visit to the Toroweap Valley was also included in the final field season.

Judd's reconnaissances documented considerable variability in site types. He concluded that the Strip's prehistoric inhabitants were related to those of the San Juan Four Corners area, although the nature of the relationship was not explicitly defined. Judd also documented the prevalence of pothunting activities in the area, noting that several sites, which were pristine when he visited them in 1915, had been looted by the local inhabitants by 1919. Like most archaeological research of this period, Judd's findings are of limited value to modern researchers and land managers due to the lack of systematic areal coverage, precise locational information, and detailed site descriptions.

Descriptive Period: 1920-1965

The 1920s and 1930s witnessed developments in Southwestern archaeology that had a significant bearing on subsequent archaeological studies on the Arizona Strip. The cultural classifications and terminology developed during this period provided the general cultural historical framework that linked the prehistoric manifestations of the Arizona Strip to the larger context of Southwestern prehistory. That framework is still in use today.

In 1927, Alfred V. Kidder organized the first Pecos Conference, which brought together Southwestern archaeologists to discuss and compare their findings (Kidder 1927). Prior to the mid-1920s, archaeologists were forced to rely exclusively on stratigraphic evidence to place their assemblages in relative chronological order, since absolute dating methods had not yet been developed. Furthermore, Southwestern archaeologists did not have standardized terminology with which to describe and compare their findings. The members of the first Pecos Conference realized the need for a chronological framework and formal terminology to facilitate communication and comparisons between various areas of the Southwest. They noted that there were a number of material culture attributes that seemed to reflect a logical sequence of cultural development throughout the Southwest, and they developed a conceptual framework based on these changes. The Pecos Classification, as it came to be known, defined a series of developmental stages using a systematic nomenclature: Basketmaker I through III and Pueblo I through V (abbreviated as BMI-III and PI-V respectively).

Each stage in the Pecos system was characterized by distinctive technology and styles of architecture. Although these stages were presumed to reflect cultural evolution through time, they were not initially linked to a specific chronology. With the advent of dendrochronology in the 1930s, however, the stages subsequently were tied to the Christian calender. Responding to inadequacies in Kidder's original Pecos Classification, Harold S. Gladwin, founder of Gila Pueblo, and Harold S. Colton, founder of the Museum of Northern Arizona, independently undertook the task of organizing prehistoric cultural manifestations within the Southwest into a more encompassing scheme that was designed to account for all of the major cultural manifestations in the Southwest. A hybrid classification system, reflecting both men's views, eventually resulted. This dendritic classification system was based on an evolutionary model of cultural development adopted from the biological sciences. The system divided prehistoric Southwestern manifestations into several geographically meaningful cultural roots: Basketmaker, Mogollon, and Hohokam. The Basketmaker root, later renamed Anasazi (Kidder 1936), was in turn subdivided into several regional branches based on minor differences in ceramics, architecture, and other material culture elements: the Mesa Verde branch in the northern San Juan Basin, the Chaco branch in the central San Juan Basin, and the Kayenta branch in the eastern San Juan Basin and lower Little Colorado drainage (Colton 1939; Reed 1946).

Gladwin and Gladwin (1934) initially depicted a Nevada "sub-branch," which diverged from the Kayenta during PII times. Colton (1943) later proposed that the Nevada Branch be accorded a status equal to the other three branches. In addition, he suggested that the name of this branch be changed to Virgin, after the Virgin River, arguing that the name Nevada was inappropriate for a branch that occupied only a small portion of that state (Colton 1952:5). Colton's terminology was eventually adopted and Virgin Branch became the generally accepted term for referring to Anasazi manifestations in the Arizona Strip and adjoining areas north and west of the Colorado River.

Judd's hurried reconnaissance in 1920 and a brief collecting expedition sponsored by the Milwaukee Public Museum along the North Rim of Grand Canyon in 1923 (West 1925) were the only archaeological efforts conducted on the Strip during the 1920s. In his brief account of the Milwaukee Museum Expedition, George West speculated on the apparent cultural relationship between the prehistoric inhabitants of the North Rim and those of the Tsegi Canyon region in northeast Arizona, but added little to the earlier work of Judd.

In nearby areas, several significant archaeological research projects were implemented at this time. In 1920, excavations were carried out at Cave DuPont, a Basketmaker II storage and burial site eight miles northeast of Kanab, Utah (Nusbaum 1922). These excavations uncovered 31-slab lined cists, 6 burials and a fine collection of stone and perishable artifacts. The wealth of data on Basketmaker II material culture provided by these excavations has never been duplicated by later work in the area. Consequently, Nusbaum's report still serves as the primary source of information on Basketmaker II material culture in the Arizona Strip and southwest Utah.

In 1924, a large prehistoric community located on the Muddy River in southeastern Nevada was brought to the attention of archaeologists (Harrington 1925c). Although referred to collectively as "Lost City," these remains actually proved to be an extensive conglomeration of individual sites ranging from Basketmaker II to late Pueblo II in age. Excavations were undertaken by the Museum of the American Indian, Heye Foundation, under the direction of Mark Harrington in 1925 and continued the following year (Harrington 1925a, 1925b, 1927). In addition, an extensive reconnaissance survey aimed at defining the western extent of Pueblo culture was initiated in 1925 (Harrington 1926b, 1926c, 1928). This reconnaissance was extended up the Virgin River into Arizona the following year (Harrington 1926a).

In 1926, Harrington became affiliated with the Southwest Museum in Los Angeles, but his research in southeastern Nevada continued without interruption. A fairly intensive survey of the lower Moapa Valley was conducted in 1929 (Harrington 1930a, 1930d) to expand upon the information derived from excavations at Mesa House (Hayden 1930) and Paiute Cave (Harrington 1930c). Between 1933 and 1938, Harrington returned to the Muddy River area to supervise salvage excavations at sites threatened by the rising waters of Lake Mead (Harrington 1937a-d).

Harrington's work had an important bearing on future archaeological studies in the Arizona Strip. His efforts provided the foundation for the establishment of a temporal phase system that was later applied to the entire Virgin Anasazi region, including all of the Arizona Strip (Harrington 1930b; Gladwin and Gladwin 1934; Colton 1952; Shutler 1961:67, 69). The potential significance of Harrington's work was greatly diminished by his failure to publish scholarly reports. With two notable exceptions (Harrington 1930c, 1933), Harrington's publications on the archaeology of the southeastern Nevada are confined to brief anecdotal articles aimed at museum supporters and the general public. More than two decades after the conclusion of field work, Richard Shutler attempted to compile and synthesize the survey and excavation information accumulated by Harrington and others; unfortunately, by that time many of the original records and collections had been scattered and lost (Shutler 1961:13). Despite the fragmentary condition of Harrington's data, Shutler's report still serves as a primary source of information on the Puebloan occupation of the Moapa Valley and the extreme western portion of the Arizona Strip.

A number of important archaeological investigations were conducted in or adjacent to the Arizona Strip during the 1930s: 1) brief reconnaissance surveys by Gila Pueblo personnel on the Powell Plateau (Haury 1931:2, n.d.) and in the House Rock Valley, Fredonia, and Kanab Creek (Amsden n.d.) areas during the summer of 1930; 2) Steward's 1932 reconnaissance east of Kanab and along the Colorado River between Hite, Utah, and Lees Ferry, Arizona (Steward 1941); 3) Spencer's 1930 to 1932 surveys around Fredonia and along the Virgin River west of Zion National Park (Spencer 1934, 1936); 4) Ben Wetherill's and Elmer Smith's 1933 1934 surveys and excavations in Zion National Park and scattered localities across the Arizona Strip (Wetherill and Smith 1934; Smith 1940; Schroeder 1955); and 5) Hall's 1937 survey of the Walhalla Glades on the north rim of the Grand Canyon (Hall 1942).

The Gila Pueblo, Wetherill, Spencer, and Steward surveys were all nonsystematic reconnaissances rather than intensive inventories of specific localities. Although not explicitly stated at the outset, Steward's (1941:354) investigations were aimed at addressing a specific research issue, the definition of cultural boundaries. The primary goal of the other surveys was simply to document the presence of sites at various locations and to describe and compare the architectural and artifactual remains with those of surrounding regions. All of these studies concluded that the Puebloan remains in the Arizona Strip region bore a strong resemblance to those of the Four Corners region, despite differences in the particulars of ceramic design and technology and in architectural layouts. Thus, the principal contribution of these pioneering studies was in the elucidation of cultural relationships between the "Northern Periphery" (Steward 1933) and the better-known Anasazi manifestations to the southeast. In addition to the published descriptions of archaeological remains contributed by Spencer and Steward, their reconnaissances indirectly had a profound influence on future studies in the Arizona Strip. Spencer's ceramic collections and preliminary type descriptions laid the foundation for Colton's classic typology of Virgin branch ceramics (Colton 1952). Steward's descriptions of types encountered along the Paria River and in Johnson Canyon expanded the known geographical range and typological diversity of Virgin branch ceramic types.

Edward T. Hall's work on the Walhalla Plateau stands out among all the surveys of this period because it represents the first attempt at systematic study of a specific locality within the Arizona Strip. Like Steward's earlier reconnaissance survey, Hall's survey was aimed at defining cultural boundaries. Although the intensity of Hall's survey may seem low by current standards, it was extremely thorough by the standards of his time. Hall spent six weeks recording 273 sites within six square miles. Only sites with structural elements were included in the inventory. Numerous agricultural features were associated with these sites, including terraces, check dams, water diversion channels, and bordered garden plots. Judd (1926:86) had previously alluded to the possiblity that these features were related to horticultural activities, but Hall was the first to confirm their horticultural function (Hall 1942:12).

Based primarily on ceramic evidence, Hall concluded that occupation of Walhalla Glades commenced around A.D 700 and continued with a gradual population increase until ca. A.D. 900. Hall postulated that a large population influx occurred during Pueblo II times, which he attributed in part to immigrations from the Virgin River area. Hall also documented a steady increase in Virgin Anasazi ceramics relative to Kayenta Anasazi wares during Pueblo II. He interpreted the shift in relative ceramic proportions as evidence of increasing Virgin Anasazi influence in the region until the area's abandonment around A.D. 1200. Hall's report has been criticized for its lack of detailed site and artifact descriptions, and for the simplistic cultural historical reconstruction that equates pottery frequencies with populations (Schwartz 1966; Effland et al. 1981). Despite these criticisms and the fact that his work has been superceded by more recent studies (Schwartz et al. 1981; Jones 1986a), Hall's study stands out as one of the major contributions to Arizona Strip archaeology.

Two significant projects--Harrington's (1933) excavation of Gypsum Cave and Wheeler's (1942) investigations at Etna Cave--were conducted in southeastern Nevada during the 1930s. These excavations had a direct bearing on later interpretations of Arizona Strip prehistory. Both caves contained deep stratified deposits and were initially thought to have been occupied during the Paleoindian period. The dating of the earliest Gypsum Cave occupation at 8500 B.C. (Harrington 1933:188) was based on the purported association of distinctive contracting stemmed projectile points with the dung of extinct ground sloth. The temporal placement of the earliest Etna Cave deposits was in turn based on cross correlations of projectile points with the supposedly early Gypsum Cave points. Later studies (Fowler 1973; Holmer 1978; Schroedl 1976) successfully argued that mixing of the deposits in Gypsum Cave had obscured cultural associations, and that the purported association of Gypsum Cave points and Pleistocene sloth dung in the lowermost levels was falacious. Both Gypsum and Etna Cave are now thought to have been initially occupied during the late Archaic period, ca. 2000 B.C. (Jennings 1974:170).

Between 1935 and 1937, Edward T. Schenk conducted surveys along the Colorado River from the junction of the Virgin River upstream to Last Chance Rapids, a distance of approximately 34 miles. He documented sites in the Grand Wash-God's Pocket area, around Columbine Falls, Travertine Warm Springs, and Quartermaster Canyon. The sites included rockshelters, open camps, petroglyphs, artifact scatters, and mescal pits. Several of the rockshelters threatened by the rising water of Lake Mead were tested. At least two of the shelters contained stratified deposits over two feet deep, and produced fragments of basketry, sandals, fibers, and quids. Schenk (1937) prepared a preliminary report on the work, but no final publication was forthcoming.

During the 1940s, Gordon Baldwin conducted a reconnaissance survey on the Shivwits Plateau, including Whitmore Canyon (Baldwin 1978). Most of the 52 sites recorded by Baldwin were surface artifact scatters, although a few multiroom pueblos were also found. Baldwin concluded that the area had been used primarily for hunting and gathering activities; only the most favored habitats had been used for habitation. Baldwin saw affinities between the artifactual assemblages and architectural layouts of the Shivwits sites and the Puebloan period remains of the Muddy River valley, but he also noted differences, particularly in ceramics, which he felt warranted further study. Baldwin's investigations provided the first survey coverage within the western portion of the Arizona Strip. His brief report remained the definitive document on the archaeological resources of that area for several succeeding decades.

Baldwin's subsequent work in the Lake Mead area during the 1940s and early 1950s (Baldwin 1942a, 1942b, 1945, 1946, 1948, 1950a) contributed indirectly to the growing data base on Arizona Strip archaeology. Although the potential of Baldwin's work was greatly diminished by his failure to publish detailed reports, the few articles that were disseminated had significant impacts on later research in the area. For example, Baldwin was the first to describe the occurrence of olivine temper in ceramics from the Moapa Valley and recognize its value for tracing prehistoric ceramic exchange among the Virgin Anasazi (Baldwin 1945). Another brief but informative article on Southern Paiute ceramics (Baldwin 1950b) is still a primary reference for archaeologists.

In 1952, Colton published Pottery Types of the Arizona Strip, his first volume in a series on Southwestern ceramic typology. Still the standard reference on this subject, it can safely lay claim to being the most influential publication in the history of Arizona Strip archaeology. Despite its widespread use, Colton's classification of Arizona Strip ceramics has perplexed and frustrated archaeologists since its inception. A major problem with Colton's classification is that it was originally based on a relatively small sample of sherds collected by Spencer along the middle Virgin River drainage. Collections taken by Ben Wetherill, Julian Steward, Gordon Baldwin, and various amateur collectors were subsequently incorporated into the database, and the original typology (initially developed by Lyndon Hargrave in the early 1930s) was revised to reflect the additional information. The final version ultimately relied on ceramics collected primarily from the northern and western periphery of the general Virgin Anasazi area. Consequently, the full range of variation exhibited by ceramics over the entire Arizona Strip was never adequately described. This problem was further compounded by ambiguities in Colton's attribute descriptions, particularly with respect to his characterization of clays and temper. Furthermore, Colton's lack of personal familiarity with the archaeology of the region led him to suggest that design styles on the pottery from the Arizona Strip were basically analogous to those of the Kayenta Anasazi region east of the Colorado River, an assumption that has proven to be only partially valid.

Not surprisingly, a great deal of inconsistency in the application of Colton's typology has developed over the years. Repeated attempts at pigeonholing ceramics into the defined types and wares has met with only partial success, prompting considerable debate over the "proper" classification of Virgin Branch ceramics (e.g., Anderson 1960; Aikens 1965; Lipe 1960; F. Lister 1959, 1964; Thompson 1971b; Tipps 1983). Many researchers have suggested that the Colton typology be scrapped and a new classification developed, but no one as yet has had the temerity to attempt it. Fortunately, there are a growing number of scholars who recognize that detailed, attribute-based analyses of ceramics are prerequisites to discussing ceramic production and exchange within the Virgin Anasazi region on more than a speculative basis (e.g., Acker 1983; Lyneis 1986b, 1987; Olson 1979). Future attribute-based analyses will undoubtedly provide additional information on the full range of local ceramic variability, and will eventually provide the basis for a full scale revision of Colton's Arizona Strip typology comparable to those already accomplished for some other Southwestern subregions (e.g. Madsen 1977; Breternitz et al. 1974).

Despite decades of interest in the region, no archaeological sites were excavated on the Arizona Strip until the early 1950s. In 1954, Robert C. Euler and Milton Wetherill, then associated with the Museum of Northern Arizona in Flagstaff, conducted test excavations in the stratified deposits of Antelope Cave, a deep limestone solution cavern on the Uinkaret Plateau. The excavations produced an assortment of artifacts attributed primarily to Basketmaker III and Pueblo II occupations, but failed to document the presence of earlier occupation contemporary with the Gypsum Cave materials, as had been originally hoped (Robert C. Euler, personal communication 1986). A brief inventory of artifacts was the only documentation resulting from this initial work (Euler n.d.). Subsequent excavations were conducted at Antelope Cave by University of California at Los Angeles (UCLA) fieldschools under the direction of David M. Pendergast and Keith L. Johnson in 1956 and 1957. Looting at the site by local pothunters prompted Johnson and Pendergast to return in 1958 and 1959 to salvage additional information and materials. A brief preliminary report and an incomplete artifact inventory were the only accounts of this later work (Johnson and Pendergast 1960). The lack of published information on this intensively occupied and potentially informative site and the concomitant loss of comparative data for future studies in the area illustrates a pervasive problem, endemic to the archaeological profession in general, which has hampered progress on a number of important research issues within the Arizona Strip.

Fortunately, not all 1950s excavations in the Arizona Strip region went unreported. One important example from this period is the excavation report from Willow Beach (Schroeder 1961). Located just beyond the southwestern fringe of the Arizona Strip on a natural travel corridor between the Shivwits Plateau and the lower Colorado River, this open, stratified site had been previously tested in 1936 by Willis Evans, working under the direction of Harrington (1937d), and by Gordon Baldwin in 1947 and 1948. Albert Schroeder excavated at the site in 1950, and the results of all three excavations were incorporated into Schroeder's final report. The excavations revealed evidence of sporadic short term use by various cultural groups from ca. 250 B.C. through the late Protohistoric periods. Schroeder recognized eight cultural strata, including five preceramic and three ceramic levels, which he divided into five occupational phases based on projectile point styles and other associated artifacts.

Schroeder interpreted Willow Beach as a campsite along a frequently traveled trade route linking the Arizona Strip via the Virgin River valley to southern California. He viewed the diachronic changes in artifactual assemblages as indicative of shifts in cross-cultural interactions due to population movements. Unpublished survey and excavation data collected by Baldwin and others from sites in the Virgin River basin, Grand Wash Cliffs, and Shivwits Plateau were incorporated into his interpretive discussion. Although criticism has been raised regarding certain aspects of Schroeder's interpretation, particularly his assignment of the lowest cultural level to a "western variant of Basketmaker II" (Euler 1962; R.G. Matson, personal communication 1986), the Willow Beach report remains an important source of information on prehistoric trade and cross- cultural interaction between the inhabitants of the Arizona Strip and neighboring populations.

The 1950s witnessed a surge of interest in the prehistory of the region north and east of the Arizona Strip. Although several small surveys and salvage excavations conducted in advance of reservoir construction projects near Zion National Park and St. George, Utah (Rudy and Stirland 1950; Gunnerson 1960) focused attention on the cultural resources of southwestern Utah, it was the massive Glen Canyon Project of the late 1950s and early 1960s that was primarily responsible for rekindling professional interest in the archaeology of the northern Anasazi "frontier." Between 1956 and 1959, archaeologists from the Museum of Northern Arizona (MNA) and the University of Utah (UU) conducted extensive surveys within Glen Canyon below the 3700 ft pool level, resulting in an inventory of approximately 2000 sites. Roughly 10 percent of these sites were excavated or tested between 1957 and 1961. Early on in the project, archaeologists recognized that surveys and excavations outside the reservoir area would be necessary to place the inner canyon sites in a meaningful regional perspective. Beginning in 1958, archaeological investigations were initiated at the Coombs site in Boulder, Utah, and surveys and excavations were subsequently carried out in the Escalante drainage as well as on the Kaiparowits Plateau and around Navajo Mountain, Utah (Aikens 1962; Ambler et al. 1964; Fowler and Aikens 1963; Fowler et al. 1959; Gunnerson 1959a, 1959b; Lindsay et al. 1968; R. Lister 1959; Lister et al. 1960; Lister and Lister 1961).

Most of the descriptive reports resulting from the Glen Canyon surveys and excavations lacked interpretive discussions; nevertheless, they raised numerous questions pertaining to the prehistoric occupation of the Arizona-Utah border area, particularly with respect to Anasazi subsistence and cultural interactions (Jennings 1966). Of particular relevance to Arizona Strip archaeology were the surveys and excavations reported by Adams et al. (1961), Gunnerson (1959a, 1959b), Fowler and Aikens (1963), R. Lister (1959; Lister et al. 1960; Lister and Lister 1961), and Long (1966), and a synthesis of Glen Canyon ceramics by F. Lister (1964). These studies focused attention on Virgin branch manifestations within the Glen Canyon region and prompted discussions on the validity of the Virgin Kayenta dichotomy. The latter research issue was subsequently followed up by Aikens (1965, 1966).

In 1962 and 1963, Melvin C. Aikens directed the excavation of eight Virgin Anasazi sites in southwestern Utah. The primary purpose of the project was to gather basic data on the full range of Virgin Anasazi material culture in order to provide a basis for comparing and distinguishing Virgin and Kayenta archaeological manifestations in the Glen Canyon region (Aikens 1965:1). The eight sites included an extensively occupied pithouse village and an open storage (and habitation?) site in Johnson Canyon east of Kanab, two sheltered storage and camp sites and one open storage site in Zion National Park, and three open habitation sites along the middle Virgin and Santa Clara Rivers near St. George. Because these sites constitute one of the principal data sources on Virgin Anasazi material culture, they are briefly reviewed below.

The Parunuweap Knoll site in Zion and the Goosenecks Overlook site west of St. George both consisted of a series of slab-lined circular storage cists dating to the early-middle Developmental period, ca. A.D. 700 to 1000. At least one habitation unit was also present at the Goosenecks Overlook. The two sheltered sites in Zion, Lamb's Knoll Caves No. 1 and 2, had both intermittent PII and subsequent Southern Paiute occupations. The Bonanza Dune site and the Sandhill site in Johnson Canyon were both predominantly PII, although the occupation at Bonanza Dune may have commenced as early as A.D. 900. Excavation at Bonanza Dune revealed 21 pit structures, including at least 11 habitations and one masonry lined kiva. Many of the structures were superimposed one on top of another, clearly indicating that not all of the structures were contemporaneous. At the Sandhill site, only surface masonry storage rooms were uncovered. This was somewhat surprising since the quantity and diversity of artifacts suggested a habitation function for the site. The Reusch site, a small habitation site along the Virgin River south of Washington, Utah, was not fully excavated, because the integrity of the site had been largely destroyed by pothunting. Excavation revealed two pithouses and one storage structure. The superposition of the storage structure over one of the pithouses, in conjunction with over three feet of cultural deposits within the dune, indicated that the occupation involved more than a single short-lived episode. Finally, Three Mile Ruin on the Santa Clara River consisted of a contiguous series of surface habitation and storage rooms arranged in a circle around a central plaza. Only a portion of the site was excavated, including 12 surface rooms and two pit structures. The rooms were constructed of roughly coursed sandstone blocks and river cobbles laid in copious amounts of mortar. Ceramics placed the occupation between A.D. 900 and 1200.

As the foregoing descriptions indicate, Aiken's work revealed considerable diversity in the types of sites ascribed to the Virgin Anasazi. The primary difficulties with interpreting his findings result from the lack of sufficient chronological control and the fact that several of the sites appear to have been occupied over a considerable time span. Since it is impossible to determine which sites or structures within sites were actually contemporaneous, it is unclear whether some of the observed architectural (and artifactual?) variability is actually temporally dependent.

Aikens (1966) subsequently incorporated the data from his 1962-1963 excavations into a synthetic study of Virgin Kayenta cultural relationships. He felt that previous researchers had placed undue emphasis on ceramic attributes in separating the Virgin and Kayenta branches, and he questioned the validity of distinguishing the Virgin and Kayenta Anasazi as separate, albeit closely related, cultural entities. Aikens compared the two branches using material cultural traits other than ceramics, as well as data pertaining to subsistence practices and socioreligious organization. He concluded that the two branches shared a common developmental history until ca. A.D. 900, but that after this time, regional differentiation became increasingly pronounced. Nevertheless, Aikens emphasized the basic continuity in cultural patterns over the entire northern Southwest throughout the developmental sequence, from ca. A.D. 1 to abandonment of the Virgin Anasazi region around A.D. 1150, noting that regional differentation during the PII period was a common phenomenon through the Anasazi culture area.

Aikens' (1966) synthetic study of Virgin Kayenta relationships has been characterized as a landmark publication in the archaeological literature from the Arizona Strip region (Thompson 1970:2), and it continues to have a profound influence on current interpretations of western Anasazi prehistory. In light of current theoretical approaches and methodologies, however, Aikens's study is seriously flawed. Aikens was forced to rely on comparisons of material culture remains, because information pertaining to Virgin Anasazi adaptive strategies was (and for the most part continues to be) virtually non-existent. Moreover, the level at which he compared the Virgin and Kayenta branches was not sufficiently detailed to discern regional distinctions in material culture patterning. In other words, his conclusions regarding the fundamental similarity between the Virgin and Kayenta would have been the same for all the other Anasazi subcultures, if they had been included in his study. Although the study was important for its synthesis of basic Virgin and Kayenta Anasazi data gathered up to that time, it is clearly outdated. A fresh approach to the issue of Kayenta Virgin relationships that would analyze the processes responsible for cultural development and change and incorporate the substantial body of additional information collected from the Kayenta and Virgin regions over the past two decades is now urgently needed.

Concurrent with the inception of the Glen Canyon archaeological studies to the east, the southern margins of the Strip were receiving increasing attention. Prior to the 1950s, the only expeditions to deal with the cultural resources of the inner Grand Canyon were Judd's brief foray down Bright Angel Creek in 1920, the reconnaissance and testing by the Milwaukee Public Museum expedition in the same area three years later, and Haury's reconnaissance for Gila Pueblo in June, 1930. In the intervening decades, archaeological sites within Grand Canyon remained unexplored by professional archaeologists, although park rangers and river boatman occasionally reported the presence of Pueblo-like ruins and artifact caches encountered along canyon trails and the river corridor (Sturdevant 1928; Count 1930; Soper 1930; McKee 1933).

In 1953, professional archaeological investigations within the inner gorge of Grand Canyon were initiated once again. In that year, Walter W. Taylor conducted a "brief and hurried" survey along the river corridor between Lees Ferry and Lake Mead (Taylor 1958:23). Based on the limited evidence collected from sites at the mouths of South Canyon, Nankoweap, Unkar, and Bright Angel creeks on the north side of the river, and opposite Deer Creek on the south side, Taylor (1958:29) concluded that there had been only a sparse occupation of the inner canyon, primarily between A.D. 1000 and 1150, by Kayenta Anasazi-affiliated populations from the North Rim. An additional contribution of this survey was the documentation of local ceramic variablity, particularly in the gray wares, which Taylor attributed to local ceramic production techniques and the use of locally available clays and temper. His observations foreshadowed later discussions on this topic (e.g., Marshall 1980:329; Wilson 1985; Balsom 1984).

In 1954, spelunkers reported the discovery of split twig figurines from four caves within the inner Grand Canyon south of the river (Farmer and De Saussure 1955). Similar figurines had been found at Etna Cave in southeastern Nevada in purported association with Basketmaker III materials (Wheeler 1942). On this basis, a Puebloan period affiliation was initially suggested for the Grand Canyon specimens (Farmer and De Saussure 1955:22). Douglas W. Schwartz excavated four of the Grand Canyon figurine caves in 1957, and many more specimens were recovered (Schwartz et al. 1958). Radiocarbon dating of two figurines at 3530 ± 300 B.P. and 3100 ± 110 B.P. (ca. 1580 B.C. and 1150 B.C.) provided the first firm evidence of an Archaic presence in the Grand Canyon Arizona Strip region. Subsequent dating of a figurine from Stanton's Cave on the north side of the river in Marble Canyon pushed the date for figurine manufacture and Archaic occupation of the Grand Canyon back to 4095 ± 100 B.P. (ca. 2100 B.C.) (Euler and Olson 1965). None of the figurines were recovered from stratigraphic contexts, and no other cultural materials were directly associated with them. Schwartz et al. (1958) suggested that the figurines had been deposited by Desert Culture hunter-gatherers as part of a ritual involving imitative hunting magic. Euler and Olson (1965:369) concurred with this hypothesis and further suggested that the figurine makers may have been affiliated with the Great Basin Pinto complex, since artifacts diagnostic of this complex had been found on the south rim of Grand Canyon (McNutt and Euler 1966).

In 1969, Euler initiated excavations at Stanton's Cave in Marble Canyon in hopes of finding cultural materials in stratigraphic association with figurines. A wealth of paleoclimate, faunal and sedimentological data were recovered in addition to numerous figurines, but little additional light was shed on the material correlates of the Grand Canyon figurine complex (Euler 1984). The temporal placement of the Pinto complex and cultural affiliation of the Grand Canyon figurine complex continues to be debated by archaeologists (Schroedl 1977; cf. Euler 1984); however, the dating of the figurines to the late Archaic period is undisputed.

A rapid succession of more intensive surveys along the north side of the river commenced during the late 1950s. Areas investigated included Shinumo Canyon (Schwartz 1960), upper Nankoweap Canyon (Schwartz 1963; Kelly 1971), the river corridor between Nankoweap and Unkar (Schwartz 1965; Euler and Taylor 1966), and Marble Canyon from Lees Ferry to the Marble Canyon dam site (Euler 1963). In addition, Euler conducted an extensive helicopter reconnaissance of the less accessible areas of the inner canyon, recording approximately 200 previously undocumented sites (Euler 1967a, 1967b). None of these surveys were intensive by current standards, although they were more thorough than any previous reconnaissances in the area. The surveys revealed a canyon-wide Pueblo II settlement pattern characterized by small dispersed habitations concentrated along arable portions of spring-fed tributaries. Ceramics indicated that the Anasazi occupation spanned a 300 year period between A.D. 900-1200, with the period of greatest population density centered between A.D. 1050 and 1150.

Cultural Resource Management Studies: 1966-Present

While a considerable amount of research was in progress around the periphery of the Arizona Strip during the 1950s and early 1960s, the core of the region continued to be a large blank on archaeological maps. This situation finally began to change in the mid-1960s. The increase in fieldwork during the late 1960s was fueled by the growing awareness of cultural resource management concerns and by the ensuing legal obligations of state and federal land management agencies to protect these resources.

The first major project of this nature was initiated in December 1964 when the Arizona State Highway Department and the Federal Highway Administration contracted with the Museum of Northern Arizona (MNA) to salvage 16 sites along the proposed right-of-way for Highway 389 between Fredonia and Littlefield, and 3 sites along the Arizona segment of Interstate 15 south of Littlefield. Although only the portions of sites lying within the right-of-way were excavated, a wealth of information was recovered. Most of the sites were pithouse habitations with associated masonry storage rooms and extensive trash deposits dating to the late Pueblo I-mid Pueblo II period (ca. A.D. 850- 1100). A total of 39 pithouses, 20+ surface rooms, 30+ cists, 30 extramural hearths, 2 rockshelters, and 17 burials were excavated over a 2 year period. A lengthy descriptive report produced shortly after completion of the project in 1966 remains unpublished (Wade 1967).

In addition to the work reported by Wade, one other significant excavation was conducted in the Virgin River gorge in conjunction with the I-15 salvage project. The Wild Goose site (NA 9059; AZ:A:1:12 [ASM]), a rockshelter and associated midden deposit on the banks of the Virgin River, was excavated cooperatively by the MNA and Arizona State Museum (ASM) in late 1968 and the summer of 1969. The midden revealed at least nine cultural strata in over 2 m of deposits, representing at least four cultural periods: preceramic, Basketmaker III-Pueblo I, Pueblo II, and historic. Only a preliminary report (Staley 1969) and a rough draft of the final manuscript (Carmichael 1980) are available at this time, neither of which is adequate for assessing the cultural significance of this potentially informative site.

In 1967, MNA archaeologists working under contract with the Bureau of Land Management (BLM) initiated an intensive multi- year survey of lands on and adjacent to the Paria Plateau (Haskell 1978; Jennings 1978; Mueller et al. 1968; Mueller 1972; Bradford 1974). The survey of the upper House Rock Valley and the western one-third of the Paria Plateau provided the first comprehensive inventory of archaeological resources within the eastern portion of the Strip. Although it was intended to be an intensive inventory, not all areas were investigated with the same degree of intensity. For example, pedestrian survey of the sagebrush flats on top of the plateau was discontinued after initial inspection failed to locate any sites. Thereafter, only those areas where sites were anticipated to occur were examined. In these areas, the survey transects varied from 50 to 150 yards between surveyors, depending on the terrain and observed site distributions (Mueller 1972).

The 1967-1968 survey inventoried 498 prehistoric sites in a 85.5 sq mi area. Over half the sites (272) were masonry pueblos ranging from small, 1 to 5 room structures (72% of the pueblos) to large pueblos with 16 to 50 rooms (8.5%). Sherd scatters and pithouses were the next most common site types (95 and 67 sites, respectively), followed by isolated features (29), and sherd and lithic scatters (22). Aceramic rockshelters (6 sites), lithic scatters (5 sites), and rock art (2 sites) were the least common site types. The preponderance of pueblos, pithouse sites, and other obvious Anasazi (i.e., ceramic) sites undoubtedly reflects to some extent the lesser importance accorded aceramic artifact scatters by the Paria Plateau field archaeologists and by Southwestern archaeologists in general during the mid-1960s; the totals may also be skewed by the judgmental approach employed in the survey (J. Richard Ambler, personal communication 1987). Nevertheless, it is clear that the plateau was intensively utilized by the Anasazi during the Pueblo II-III period: 366 of the 467 ceramic-bearing sites had late Pueblo II ceramic components and 172 of these showed evidence of continuing use during early Pueblo III. This intensive occupation may well have obscured evidence pertaining to the earlier (and presumably less intensive) use of the area.

As noted above, most of the sites recorded on the Paria Plateau dated to the Pueblo II and early Pueblo III periods, or ca. A.D. 1000-1200 (Haskell 1978; Mueller et al. 1968). Earlier ceramic (Basketmaker III-Pueblo I) occupations were sparsely represented. Limited Archaic and Basketmaker II use of the area was suggested by the presence of six Pinto points and several dozen San Pedro and Amargosa-like projectile points occurring on multicomponent sites. Evidence of post A.D. 1300 occupation was restricted to a few sherds of Jeddito Yellow ware from a single site on the plateau.

These Hopi sherds are most likely evidence of a late prehistoric Paiute presence on the plateau, rather than an indication of Hopi visitation (Baldwin 1944:16). Relying primarily on ceramic evidence, Mueller et al. (1968; Mueller 1972:28) argued that an initial low density Puebloan occupation took place on the plateau during Basketmaker III or Pueblo I times. This initial occupation was followed by a dramatic population increase in early to middle Pueblo II times, with the maximum population occurring in late Pueblo II. Population declined in the mid-A.D. 1100s, with complete abandonment of the area around A.D. 1200. Like many previous and subsequent reports dealing with Anasazi manifestations in the eastern Strip, authors of the Paria reports acknowledged considerable difficulty in separating Virgin and Kayenta ceramics. They were therefore reluctant to assign the Puebloan sites to a specific cultural branch. This research problem continues to be a focus of discussion among archaeologists working on the Arizona Strip (e.g., Thompson 1978b; Effland et al. 1981; Schwartz et al. 1979, 1980, 1981; Jones 1986b).

A survey of Paria Canyon was also undertaken in 1967. Initially, it involved an informal reconnaissance by personnel from MNA and the BLM Arizona Strip District to assess the nature and extent of cultural resources within the newly proposed Paria Canyon Primitive Area. Nine previously unrecorded sites were located during the 1967 survey (Jennings 1978), including five sheltered camps, two petroglyph panels, and two lithic workshop areas. Two structural sites previously recorded in the lower reaches of the canyon (Steward 1941; Euler 1967c) were also documented.

In 1974, MNA returned to the Paria Primitive Area and conducted a more thorough inventory of cultural resources to provide the BLM with data for recreational planning purposes. Eleven previously unrecorded sites were located within the Primitive Area and three others were documented outside the project area boundaries (Bradford 1974). With the exception of one site with structural remains, the sites consisted of petroglyphs, some of which had sparse artifact scatters associated. Bradford interpreted the temporal affiliations of the rock art using Turner's (1963) typology from Glen Canyon. He noted that Turner's Style 4, characteristic of PII and early PIII, was the dominant style throughout the area (Bradford 1974:18-19). Basketmaker III and PIII-IV styles were present in lesser numbers. Bradford also documented Fremont and Great Basin motifs, which he attributed to sporadic Fremont use of the area. This interpretation was supported by the occurrence of Fremont ceramics at three sites in the area. The fact that Great Basin motifs were superimposed over Anasazi styles at site NA9793, however, argues for a Southern Paiute affiliation for at least one of these panels.

The combined results of the 1967 and 1974 surveys indicated that seasonal or year round occupation of the Paria drainage south of the Arizona State line was restricted to the broadest areas of the canyon, one to three miles above the confluence with the Colorado River. All three structural sites dating to the late PII early PIII period were found in this area. Bradford concurred with Jennings' conclusion that Paria Canyon had been used intermittently by various cultural groups over a considerable span of time, primarily as a travel corridor and camp area for transient hunting and gathering parties.

Not all archaeological work conducted on the Strip during the late 1960s was prompted by cultural resource management concerns. In 1967, Richard Thompson of Southern Utah State College initiated a long term research project in the Toroweap Valley area of Grand Canyon National Monument, now part of Grand Canyon National Park (Thompson 1970, 1971a, 1971b). Thompson's survey work was the first concerted effort to describe the prehistoric occupation of the Uinkaret Plateau. The first season of survey concentrated in a six sq mi area south of the Pine Mountains in a valley locally known as The Cove. The survey area was expanded to include the adjoining Kanab Plateau during the following two seasons of fieldwork (Thompson 1971b). The survey was a judgmental reconnaissance (Richard A.Thompson, personal communication 1986), with primary emphasis placed on the Formative (Anasazi) period and to a lesser extent the Paiute occupation. Although the survey was not comprehensive, the preliminary results (Thompson 1971b) provide a useful foundation for formulating additional research questions pertaining to the Anasazi occupation of this previously little known region.

A total of 188 sites were recorded during the first three seasons of survey in Grand Canyon National Monument; an additional 163 were inventoried over the following eight years. Thompson noted distinct differences in the types, functions, and temporal affiliations of sites in various ecological zones within the Monument, which he attributed to a combination of factors, including demographic movements. Thompson found Pueblo I through early Pueblo II sites concentrated on the southern flanks of the Pine Mountains, while later PII sites tended to occur to the east of the Toroweap Valley towards the rim of the Kanab Plateau (Thompson 1971b). He also found that specific subsistence activities correlated with specific environmental zones, regardless of their cultural or temporal affiliation, as exemplified by mescal roasting pits occurring primarily on the Esplanade. The utility of Thompson's work for cultural resource management purposes is limited by his failure to provide detailed information on survey methods and intensity of coverage. Nevertheless, the project generated numerous questions regarding the cultural affiliations, adaptive strategies, growth, and decline of the local Puebloan and Shoshonean inhabitants. These questions provide points of departure for future research efforts in the area.

In 1972, Thompson expanded the scope of his research to include subsurface investigations. Excavations were conducted at three sites in 1972-1973: GC670, GC671, and GC663 (Thompson and Thompson 1974). GC670, an isolated storage cist, was the smallest and least complex site. Little information other than structural data was gained from the excavation. GC671 was selected for excavation because it appeared to be a single component habitation dating to the latter part of the Anasazi occupation (e.g. post-A.D. 1100). A carbon sample from Structure 1 produced a C-14 date of 720 ± 100 B.P. (A.D.1130-1330), while three other samples from Structure 3 produced dates ranging from 840 ± 100 to 630 ± 100 B.P. (A.D. 1010 to 1420). Thompson interpreted these dates as evidence that the occupation at GC671 continued into the mid-A.D. 1200s, at least 100 years beyond the A.D. 1150 date generally given for the abandonment of the Arizona Strip (e.g., Euler et al. 1979). The third site, GC663, was a complex multicomponent pithouse village site. Exceptionally early dates ranging between 163 ± 90 to 185 ± 90 B.P. (A.D. 410 to A.D. 10) were obtained from pit structures associated with plain gray ceramics. Thompson accepted these dates as valid evidence of pottery manufacturing in the Strip region prior to A.D. 500, an interpretation that many of his colleagues find hard to accept. Objective evaluation of the radiocarbon data has been hindered by the lack of published information on these excavations. At present, written documentation of the Tuweep excavations is limited to two relatively brief and incomplete preliminary reports (Thompson and Thompson 1974, 1978).

Concurrent with Thompson's work in the Tuweep area, an ambitious archaeological research project was undertaken by the School of American Research (SAR) in the eastern sector of Grand Canyon National Park. This multiyear project was designed to address questions raised by earlier surveys, particularly regarding Puebloan adaptation to the canyon environment. The first season of fieldwork involved intensive survey and mapping of Unkar Delta. Fifty-two loci of human activity were identified on the delta. Seventeen of these were tested, and one seven room pueblo with an associated kiva was fully excavated. The 1968 season was devoted to the complete or extensive excavation of 20 sites and the testing of three others.

Ceramic evidence collected from the survey indicated that the first occupants of the delta had been affiliated with the Cohonina settlements on the South Rim. After this initial short- lived occupation around A.D. 900, there was an occupational hiatus of a century and a half. Kayenta Anasazi moved in around A.D. 1050. Evidence of their horticultural activities included architectural and artifactual remains (e.g., check dams, terraces, trough metates) as well as macrobotanical remains of corn, squash, and cotton bolls. On the basis of survey and excavation data, Schwartz identified three occupational phases between A.D. 1050-1150, which he attributed in part to periodic abandonments and resettlement of the delta (Schwartz et al. 1980). Each occupational phase was distinguished by changes in site layouts, settlement locations, and ceramic assemblages.

In 1969, the SAR project shifted its focus to the Walhalla Glades, an extension of the Kaibab Plateau north of Unkar Delta. Survey and excavation in this highland area was designed to provide detailed data comparable to that from Unkar Delta and complementary to the earlier work of Hall (Schwartz et al. 1981:9). Over 60 sites were recorded within three judgmentally selected areas encompassing a range of topographic and vegetative variability. One large pueblo site (GC212) was completely excavated and 21 other sites were tested. In addition to the work on Walhalla, a three person crew spent the season excavating a six-room pueblo at the mouth of Bright Angel Creek (Schwartz et al. 1979). The 1970 work included additional survey of three small areas on the plateau and intensive survey of Unkar Canyon. Four sites were completely excavated, and 21 others were tested with varying degrees of intensity.

The 1969-1970 SAR surveys and excavations revealed an occupational history basically similar to that of Unkar Delta. Schwartz postulated that the Unkar and Walhalla Plateau sites constituted a single settlement-subsistence system involving seasonal movements between uplands and lowlands. Sites on the Walhalla Plateau reflected summertime occupations by Puebloan farmers from Unkar Delta and other inner canyon settlements. He based this interpretation on several lines of circumstantial evidence: 1) paucity of artifacts and lack of kivas at the Walhalla sites, 2) abundance of agricultural features on the plateau, 3) contemporaneity and overall similarity of ceramic assemblages in both areas, 4) severity of winters on the plateau, and 5) accessibility of the plateau from the inner canyon (Schwartz et al. 1981:130-131).

The information generated by the SAR Grand Canyon Project provides the most detailed and comprehensive data set available from anywhere on the Arizona Strip. In many respects, however, the project fell short of its intended goals. One of the main objectives of the project was to investigate the factors responsible for cultural change, but only one factor -- climate change was discussed in the final reports. This discussion relied on tree-ring data collected from areas outside the Grand Canyon region because no suitable dendrochronological specimens were recovered from the excavations (Dean and Robinson 1977). Although pollen samples were collected, they were not analyzed for evidence of climate change or seasonality of site occupation. Therefore, the hypothesized summer occupation of Walhalla sites and complimentary winter use of Unkar Delta could not be fully tested. Nevertheless, the project did produce a series of detailed descriptive reports documenting the architectural and artifactual characteristics of Puebloan period archaeology in the eastern Grand Canyon. Furthermore, the reports were written by original project participants, a rare occurrence in Arizona Strip archaeology until very recently.

A major boon for archaeological studies on the Arizona Strip during the 1970s was the creation of cultural resource management positions within the Bureau of Land Management, National Park Service (NPS) and U.S. Forest Service (USFS). The Park Service took the lead in this regard, hiring a full time archaeologist for the Grand Canyon in 1974. Prior to the mid 1970s, the BLM and USFS positions were filled on a project specific basis by existing personnel from various internal departments, most of whom lacked specialized training in recognizing and recording cultural resources. Beginning in 1975, the Forest Service used trained archaeologists from the Southwest regional and Arizona zone offices to conduct surveys on an intermittent basis. In 1976, a full time Forest Archaeologist was hired for the Kaibab National Forest. The BLM employed a Recreational Specialist to manage cultural resource concerns until 1978, when a permanent Cultural Resources Specialist was hired. Thus, beginning in the mid 1970s, Federal lands on the Arizona Strip slated for range and road improvements, timbering operations, and a host of related development projects were subject to systematic investigations to inventory, evaluate, and protect the cultural resources contained therein. Although the inventories were specifically undertaken to address management concerns, some of the resulting data have also proved valuable for addressing research concerns. This has been particularly true of data collected in the Kaibab National Forest and Grand Canyon National Park. Examples of research oriented studies produced as a result of in-house CRM surveys include Euler and Chandler (1978) and Abbott (1979).

In addition to numerous small scale surveys (e.g., Holmer 1979; James 1974; Keller 1975, 1978a, 1979a, 1979b; Lindsay and Madsen 1978; Thompson 1978a; Wood 1979), several extensive survey and excavation projects were conducted on the Arizona Strip during the 1970s. Among the more notable

CRM projects were MNA's investigations along the Navajo-McCullough transmission line (Moffitt et al. 1978), the MNA sample survey of the Mount Trumbull area (Moffitt and Chang 1978), and the Western Archaeological Center's (WAC) sample survey of lands adjacent to Grand Canyon National Park (Teague and McClellan 1978). Other significant projects included MNA's survey of the Kaibab and Bright Angel trail corridors through Grand Canyon National Park (Brook 1979), a sample survey of a proposed powerline corridor across the Strip (Hunt and McPherson 1975), and BYU's survey of Sullivan Canyon (Miller 1978).

The right-of-way corridor for the 500 KV Navajo-McCullough transmission line zigzags along the northern margin of the Arizona Strip from the Navajo Generating Station at Page to the Arizona-Nevada border. In 1972-1973, MNA recorded 62 sites during the intensive survey of the right-of-way, and 32 of the sites were partially or intensively excavated in 1973. Eight of the excavated sites were located within the Arizona Strip, 7 were located in Arizona east of the Paria River, and the remaining 17 occurred in southern Utah. The sites were attributed to Western Archaic, Virgin Anasazi, and Southern Paiute occupations on the basis of artifactual assemblages, and several of the sites included components of all three traditions (Moffitt et al. 1978).

The Navajo-McCullough Transmission Line Project documented an extensive Archaic occupation of the Strip. Archaic use of the area was evidenced by the large number of dart-sized projectile points recovered during the survey and excavation. Many of the Archaic points occurred with later point types or ceramic artifacts, indicating either multiple occupations at the sites or reuse of the Archaic points by later Anasazi and Southern Paiute hunters. At 7 of the 13 sites with Archaic materials, however, single component occupations were defined based on the presence of numerous Archaic dart points without associated ceramics or later arrowpoints. Unfortunately, no radiocarbon dates were collected from any of the single component sites, so the Archaic temporal assignments could not be independently verified. Two radiocarbon dates from aceramic levels at two different multicomponent sites in the Beaver Dam Mountains in the southwestern corner of Utah (NA11500 and NA11634) produced dates of A.D. 190 and 280, indicating either a longer span for the Archaic occupation in this area or reuse of Archaic materials by later Basketmaker II populations. Four of the eight excavated sites within the Arizona Strip portion of the right-of-way exhibited Archaic components (NA11626, 11508, 11509, 11512). The other four sites, all lithic scatters or quarries (NA11495, 11497, 11498, 11625), were undatable (Moffitt et al. 1978).

Evidence of Anasazi activity within the transmission line corridor was limited to artifact scatters and campsites. The only possible Anasazi structure encountered during the project was a dry laid wall in a rockshelter. Within the Arizona Strip portion of the right-of-way, one multicomponent base camp site with sparse Anasazi ceramics was intensively investigated. The authors of the final report concluded that the Virgin Anasazi subsistence strategy involved a stronger reliance on hunting and gathering than previous researchers had acknowledged. In contrast to the earlier conclusions of Aikens (1966), they suggested that the Virgin Anasazi economy was in fact primarily dependent on foraging and hunting. Although this hypothesis accurately reflected the archaeology of the surveyed right-of- way, it is clearly not valid for the Arizona Strip region as a whole. This situation highlights one of the primary limitations of the final report (and many CRM reports in general): the failure to integrate the data collected from the specific project area within a broader, regionally based perspective.

Some of the most significant data contributed by the Navajo- McCullough transmission line project concerned the Southern Paiute occupation of the area. Twelve excavated sites contained Southern Paiute components as evidenced by the presence of Southern Paiute Utility wares (10 sites) and Desert Side-notched points (2 sites). The greatest concentration of Southern Paiute sites occurred in the pinyon juniper zone of the Beaver Dam mountains. The sites in this area tended to be large, with numerous roasting pits and substantial quantities of flaked stone and groundstone. Radiocarbon samples from three base campsites in this area produced mean dates ranging between A.D. 1420 and 1755. Only 4 of the 12 sites were single component occupations; the others had either Archaic components (1), Anasazi components (5), or both. The common occurrence of Anasazi and Paiute artifacts on the same sites, in combination with the similar appearance of certain Anasazi and Paiute brownware ceramics, led the authors of the final report to raise the possibility of a Anasazi-Paiute cultural continuum on the Strip (Moffitt et al. 1978:107). The issue of Virgin Anasazi Paiute relationships, originally raised by Gunnerson (1962, 1969), continues to be a focus of archaeological debate (Euler 1964; Fowler et al. 1973; Madsen 1975; Thompson et al. 1983).

A second powerline project carried out by the Museum of Northern Arizona shortly after completion of the Navajo- McCullough fieldwork involved the development of a predictive model for Southern California Edison's Kaiparowits Power Project (Fish et al. 1974). Because the Kaiparowits Project Phase 1 study area included large portions of southern Utah, northern Arizona, southern Nevada, and California, the final report discussed the cultural resources of the Arizona Strip on a very superficial level. The main contribution of the Phase 1 study was the development of a predictive model to delineate archaeologically sensitive areas (i.e., areas with high site densities) within the project area.

The basic assumption of the model was that all human groups tend to utilize natural resources in a nonrandom fashion to maximize the acquisition of subsistence resources with a minimum effort (Fish et al. 1974:137). Prediction of archaeological sensitivity involved numerical evaluation of the differential distribution of critical resources to determine the exploitative potential of various environments for both hunter-gatherers and horticulturalists. The five critical environmental variables considered in the model were presence of arable land, rainfall, growing season, water potential, and elevational diversity. The project area was divided into 4 sq mi units. Each unit was evaluated for the five environmental variables, with each variable ranked on a scale of one to three commensurate with its increasing potential for human utilization. Each 4 sq mi unit was then assigned a relative rating of archaeological sensitivity based on the score derived from the presence and magnitude of all variables considered together. The Phase 1 study relied on existing site data to test this model, and only limited field checking was carried out. An assessment of the preferred right- of-way corridor across the Strip was included in the Phase 1 cultural resource assessment.

A sample survey of a 75 mile-long alternative transmission line corridor was carried out in 1974 to generate information on the cultural resources specific to the Arizona Strip portion of the study area. Thirty-two one-half-mile-long transects running parallel to the proposed right-of-way were selected using an environmentally stratified random sample approach. Sixteen sites were located, including 10 lithic scatters, 4 camp sites, 1 food processing station, and 1 rockshelter base camp with stratified deposits (Hunt and McPherson 1975). Hunt evaluated the survey results using the approach outlined in Fish et al. (1974) and concluded that the alternative transmission line corridor, which ran parallel to but several miles south of the Navajo-McCullough corridor, contained higher site densities than the preferred route, which basically followed the existing corridor to the north. The Kaiparowits Project was abandoned shortly thereafter and the predictive model's validity has never been verified by additional work.

Concurrent with Hunt's survey, MNA personnel conducted an intensive inventory along the three main pedestrian corridors through Grand Canyon: the Bright Angel, South Kaibab, and North Kaibab trails (Brook 1979). The purpose of the survey was two- fold: 1) to appraise the probable impact of development along the trails upon the cultural resources, and 2) to determine the significance of the cultural resources in the central canyon area. Thirty-four sites were recorded along the 30-mi-long, 300-ft-wide corridor, including pictographs, checkdams, artifact scatters, mescal pits, and open and sheltered structural sites. Fourteen of the sites were located on the North Kaibab trail between Phantom Ranch and the North Rim, 9 of which included architectural remains. Clusters of sites occurred along Bright Angel Creek in the vicinity of tributary stream junctions. The two steepest stretches of the trail (a 3.25 mi portion north of Phantom Ranch and 2.5 mi below the North Rim) were devoid of sites. In terms of cultural resource management concerns, the most important finding of the survey was that extensive impacts from visitation had virtually destroyed the integrity of all the cultural resources within the corridor (Brook 1979:94). Brook recommended that the National Park Service implement a long-term intensive survey of the park, with emphasis placed in those areas adjacent to hiking trails, and that the impacts to sites in those areas be mitigated through excavation. The park has attempted to follow the recommendations, but lack of time, money, and manpower precludes an effective response to the ongoing problem of visitor impact.

Another important project carried out by MNA during the 1970s focused on the Mount Trumbull area. In 1975, the BLM Arizona Strip District contracted with MNA to conduct a sample survey of a 9,000 acre area acquired through a land exchange with the Kaibab National Forest. The purpose of this survey was to provide the BLM with a planning document to aid in the management and interpretation of the area's cultural resources (Moffitt and Chang 1978).

The project area was stratified by major environmental zones, and randomly selected transects within each of these zones were intensively examined. A total of 2,087 acres, or approximately 23 percent of the designated project area, were surveyed and 80 sites recorded. The eight historic sites included lumber mills and camps dating to the late 1800s and early 1900s. The 72 prehistoric sites included 10 large C-shaped pueblos, 28 smaller pueblos, 17 fieldhouses, 12 artifact scatters, 1 check dam, 1 isolated storage structure, 2 roasting pit complexes, and 2 trails. Most of these sites occurred in the pinyon-juniper zone or lower ponderosa transition zone between the 6,300 and 6,900 ft elevations. The high frequency of Anasazi habitations and fieldhouses relative to specialized resource procurement camps indicated that the area was a favored habitation area during the PII-PIII periods.

Because of the rigorous sampling strategy and the large size of the sampling fraction, the Mount Trumbull survey results can be considered reliable and representative of the project area as a whole. The published survey report (Moffitt and Chang 1978) is the only readily available summary of the archaeological resources on the southern Uinkaret Plateau. Although it was originally written as a management document, the report also serves archaeological researchers. The major drawback to the report is its lack of detail and interpretive discussion. Individual site descriptions are not available, nor are site by site artifact tabulations. Without chronological information, the issue of changing settlement distributions through time can not be addressed. Finally, the authors made no attempt to place the findings in a broader regional perspective.

A second sample survey conducted on the Strip during the mid-1970s (Teague and McClellan 1978) produced results markedly dissimiliar to those of the Mount Trumbull project. In 1975, Congress authorized a study of lands adjacent to the northern boundary of Grand Canyon National Park to evaluate their suitability for inclusion within the park. Specifically, the study area encompassed the lower Kanab Creek drainage north of the park boundary, including portions of the Kanab Plateau one mile back from the canyon rims; portions of Andrus, Parashant, and Whitmore canyons north of the park plus adjoining areas one mile back from the rims; and the portion of the Shivwits Plateau included within the Lake Mead National Recreation Area. As part of this study, the National Park Service was required "to assess and evaluate the cultural resources within the study area to determine their significance and their supportive role in maintaining the integrity of nationally significant features within Grand Canyon National Park" (Teague and McClellan 1978:5).

To accomplish this end, the Western Archaeological Center undertook a sample survey of approximately 730 sections, 380 on the Kanab Plateau and 350 in the Shivwits. The survey was originally designed to sample 2 percent of this area, but time and financial constraints forced reduction to a 1 percent sample prior to the start of fieldwork. In the end, logistical problems caused the survey coverage to be reduced even further, to less than .5 percent. Although originally intended to be an environmentally stratified random sample employing 50 x 500 m transects, only the Kanab area survey approached randomness in the true sense. Due to logistical constraints, probabilisitic sampling of the Shivwits area was abandoned in favor of a combination of systematic and judgmentally selected transects (Teague and McClellan 1978:6-8). Because of the small and unevenly distributed sample size, the variable sampling methods, and the use of transects (which tend to inflate site population), the reliability and validity of the survey results are questionable. Nevertheless, the survey results do provide preliminary data on basic cultural resource characteristics and site distributions within the area.

The Adjacent Lands Survey recorded 171 cultural resources in the study area. This figure includes 102 prehistoric sites, 5 historic sites, and 56 isolated artifacts. Five prehistoric and two historic sites were located outside the transects. Of the remaining sites, 64 were located on 142 transects within the Kanab area, and 43 were encountered along 70 transects in the Shivwits area. The prehistoric sites included 26 "quarries," 24 chipping stations, 6 unspecified lithic scatters, 15 base camps, 19 temporary camps, 2 seasonal habitations, 2 sherd scatters, 2 pictographs, and a granary. In general, sites were concentrated in the upland forested zones in both the Shivwits and Kanab areas; however this distribution may be distorted by the fact that lowland (i.e inner canyon) transects were generally restricted to drainage bottoms (Teague and McClellan 1978:8). Diagnostic artifacts from late Archaic, Anasazi, or Southern Paiute occupations were observed at 37 sites. Most of the culturally identifiable sites dated to the PII period in both areas. Three sites classified as Basketmaker III-PI and four with Southern Paiute components were restricted to the Shivwits area.

Because of the apparent predominance of camps and specialized activity sites during all time periods, the authors of the final report hypothesized that prehistoric occupation of the study area had been seasonal and primarily oriented toward hunting, gathering, quarrying, and tool production. Furthermore, the paucity of structural sites and the total lack of features such as check dams and gridded garden plots encountered during the survey led the authors to conclude that "agriculture was of little importance in the study area" (Teague and McClellan 1978:179). Subsequent work within the study area (Jennifer Jack, personal communication 1986; Westfall 1987a, 1987b) has demonstrated that both of these conclusions are erroneous.

Contemporaneous with the Adjacent Lands Survey, a Southern Utah State College (SUSC) field school under the direction of Richard Thompson undertook an excavation project on the Kaibab Paiute Indian Reservation. During the previous year (1974), two students from SUSC had conducted a survey on the reservation and recorded 111 sites within portions of four sections (Thompson 1978c). The 1975 excavations concentrated on three small sites with structural remains situated along a right-of-way for a proposed waterline. Neither the 1974 survey nor the 1975 excavations of SUSC have been published, so no evaluation of the work is possible. Publication of the survey and excavation results would contribute significantly to the Arizona Strip data base, as it is obvious from the relatively high densities of habitation sites recorded by the survey (R. Thompson, personal communication 1986) that this area is crucial for interpreting the prehistory of the Strip region.

Another sizable survey project conducted in the northwestern corner of the Strip during the 1970s was the Brigham Young University (BYU) survey of Sullivan Canyon (Miller 1978). This survey was carried out under contract with the BLM Arizona Strip District to inventory and evaluate the cultural resources that would be impacted by the proposed development of a campground and nature trail. The 1974 survey recorded 34 sites, including ll lithic tool production loci, 10 sheltered and 7 open campsites, 5 isolated roasting pits, and 1 historic mining camp. Miller interpreted the survey data as evidence that Sullivan Canyon had been used intermittently over thousands of years for short term hunting and gathering activities. A fragment of a Paleoindian Clovis point was the most notable find of the survey. If the identification is correct (cf. Lipe and Thompson 1979:52), this point fragment constitutes the only documented occurrence of Paleoindian materials within the entire Arizona Strip.

Several significant archaeological reports dealing with previously reported cultural resources on the Strip were produced in the late 1970s. Chief among these were Lipe and Thompson's (1979) cultural resource assessment of the BLM Grand Wash Planning Unit, Euler and Chandler's (1978) study of the environmental variables affecting site distributions within Grand Canyon National Park, and Abbott's (1979) summary of prehistoric occupation on the Kaibab Plateau.

Lipe and Thompson compiled all the existing information on archaeological sites within the Grand Wash Planning Unit. This data base included sites recorded during brief reconnaissances by Baldwin in 1942 (Baldwin 1978), Schroeder in 1955 (Schroeder 1961), Shutler and Griffith in 1955 and 1956 (Shutler 1961), and Evans et al. (1969), as well as the surveys and excavations conducted by ASM and MNA along the I-15 highway corridor, BYU's survey in Sullivan Canyon, MNA's various transmission line surveys, and miscellaneous CRM clearance surveys conducted by BLM archaeologists. The authors briefly discussed a number of environmental factors, including water resources, soils, and topographic relief, which they felt might be important for understanding prehistoric settlement distributions. They divided the area west of the Hurricane Cliffs into seven environmental zones, and then attempted to project the types and density of sites likely to be encountered in each zone, making recommendations for the management of each zone based on existing data. They predicted a low site density for the Hurricane Grasslands zone, medium density for the Grand Wash Lowlands, Virgin Beaver Mountains, Plateau Highlands and Sanup-Grand Wash Benches, and a high site density in the Inner Canyons and Northern (Virgin River) Lowlands zones. Lipe and Thompson concluded their report with a series of recommendations for improving the data base for the Grand Wash Planning Unit zone. Their suggestions included the use of more detailed recording methods and implementation of a comprehensive approach to the inventory of cultural resources, involving both intensive and random sample surveys. Regrettably, none of these recommendations had any noticeable impact on BLM's recording or surveying procedures in the Grand Wash Planning Unit.

Euler and Chandler's study of site distributions within Grand Canyon National Park was an outgrowth of the Southwestern Anthropological Research Group (SARG) program, a cooperative research endeavor undertaken in the early 1970s by a group of Southwestern archaeologists interested in developing a regional approach to the study of human settlement behavior. The SARG research design was specifically oriented towards answering the question: "Why did prehistoric populations locate sites where they did?" (Plog and Hill 1971:8). The participants selected a number of variables (mostly environmental) that they felt were relevant to the selection of site locations, and set out to test the importance of these various factors using a structured hypothetical deductive approach.

Euler and Chandler's study synthesized data from a variety of sources, including Euler's helicopter surveys during the mid- 1960s (Euler 1967a-c) and a number of previously unreported CRM surveys (Euler 1979; Euler et al. 1980). Pueblo II Anasazi sites were the focus of their study. The primary hypotheses to be tested included the following: 1) domestic water was the most critical resource for habitation site location; 2) access to the canyon along trails was the second most critical resource; 3) protection from the elements was the third most critical resource; and 4) food resources, except agave, were not critical to site location. These "hypotheses" were really nothing more than empirical observations of site distributions within the canyon, which in turn reflected the areas where the most intensive investigations had been performed, that is along the canyon rims, along trails, along the river, and in tributary canyons with permanent water. Because of the uneven and nonrandom distribution of survey data, the hypotheses were not amenable to testing using statistical techniques; nevertheless, the authors attempted to use statistics for this purposes, and the results were equivocal. Despite the inappropriate use of statistical techniques, Euler and Chandler's study is valuable for its synthesis and discussion of PII settlement patterns in the Grand Canyon region.

Abbott's study of site distributions on the Kaibab Plateau relied on data collected from surveys of timber sale areas, fire lines, and road improvement projects within the North Kaibab Ranger District of the Kaibab National Forest. His primary interest was a study of cultural resources located above 7,000 ft in elevation. He divided sites on the plateau into three general classes: 1) structural, 2) quarry/lithic production loci, and 3) food procurement or processing camps. Abbott found that structural sites, all ascribed to a Virgin Anasazi occupation dating between A.D. 1000-1150, were uncommon on top of the plateau but abundant in the pinyon-juniper zone along the lower flanks of the plateau. When present on the plateau, they were generally restricted to the fringes of the ponderosa zone at elevations below 7,200 ft. Quarry/lithic production and food procurement/processing sites were both common on the plateau, with the heaviest concentrations occurring in the ponderosa forest zone. These latter two site classes were distinguished by differences in artifact assemblages. Quarry/lithic production sites usually consisted of unutilized debitage and cores of local Kaibab chert. Presumably, the differences between quarries and lithic tool production loci were that the former were associated with a raw material source while the latter were not; however, this was not brought out in Abbott's discussion. Food procurement/processing sites, in contrast, exhibited a broader range of lithic artifacts including bifaces, unifaces, and utilized flakes, as well as occasional groundstone implements and ceramics. Abbott assumed that the majority of sites on the plateau, including most lithic sites, were affiliated with the Pueblo II Anasazi occupation of the surrounding territory, since evidence for an earlier Anasazi or Archaic presence was "tenuous and problematic" (Abbott 1979:134). He acknowledged the possiblity that some of the aceramic sites on the plateau might be the result of Southern Paiute activity in the area, but felt that the protohistoric occupation was minimal compared to that of the Puebloan period.

Based on this information, Abbott devised a model to explain site and artifact distributions on the Kaibab uplands. The model proposed that Anasazi utilization of the ponderosa and mixed conifer zones on the plateau had revolved around the seasonal exploitation of a single resource -- mule deer (1979:133). Abbott proposed a means for testing this model that involved calculating the frequencies of hunting related artifacts found in various vegetation zones on and around the plateau in relation to the amount of time spent by the deer in these areas. If a greater percentage of hunting implements occurred in the higher elevation areas of the plateau (n% hunting artifacts > n% time), then a late summer-fall exploitation pattern would be supported, since this is the season when the deer are concentrated on the plateau. On the other hand, if the proportions were similar in each zone (n% hunting artifacts = n% time), then year-round exploitation of the deer herds would be indicated and the model would be refuted.

Although Abbott's model and methodology were simplistic and predicated on a number of questionable assumptions, his study was important for several reasons: 1) it provided the first summary of the archaeology of the central portion of the Kaibab plateau, 2) it provided a general model of site type distributions in relation to vegetation and elevation, that could be tested and refined by subsequent work in the area, and 3) it was the first attempt at explaining archaeological manifestations on the Strip in terms of a testable subsistence settlement model. Undoubtedly the most important contribution to Arizona Strip archaeology in the late 1970s was the NPS sponsored sample survey of Powell Plateau (Effland et al. 1981). This research project involved a spatially stratified sample survey, plus a block survey of one large ridge near the center of the plateau. Total areal coverage amounted to approximately five sq km. Of the 85 sites recorded, only 9 were classified as limited activity sites. The remaining 76 sites had one or more rooms and were classed as habitations.

Effland, Jones, and Euler used the Powell Plateau data in combination with those of the School of American Research and other CRM surveys within the park (Euler 1979; Euler et al. 1980) to construct a model of Anasazi settlement subsistence systems on the North Rim between A.D. 1000 and 1150. The authors interpreted site size and distributional data as evidence of a noncentralized, locally autonomous society employing a subsistence strategy based on a combination of summer horticulture and fall-winter-spring hunting and gathering activities. Unlike the the Walhalla Plateau-Unkar Delta subsistence regime, which was interpreted as involving biseasonal movement between the inner canyon and plateau (Schwartz et al. 1980; Schwartz et al. 1981), the Powell Plateau settlement-subsistence system was interpreted as involving seasonal movements between multiroom winter pueblos and summer fieldhouses on the plateau, with minimal movement between the plateau and inner canyon. Since seasonal mobility by itself was not considered sufficiently efficient to maintain the density of sites encountered on the plateau (ca. 33 per section), the authors hypothesized that the prehistoric occupants of the Powell Plateau employed alternative adaptive strategies. According to the model, redistribution functioned as a complementary strategy to seasonal transhumance. Reciprocal exchange of ceramics, lithic raw materials, and luxury items such as turquoise and shell between the Powell Plateau population and occupants of adjoining areas was viewed as a mechanism for maintaining a network of social relationships beyond the plateau. The authors hypothesized that this social network functioned to promote pan- regional cooperation and facilitate the redistribution of critical resources during periods of localized resource imbalances (Effland et al. 1981:46). Therefore, the maintenance of this network was considered to be an essential aspect of the prehistoric settlement subsistence system. The Powell Plateau study marked the first attempt by Arizona Strip archaeologists to construct an integrated, regional model, which could explain archaeological site distributions within a given locality, and which could be applied to archaeological manifestations outside the immediate study area.

Two "pure research" field studies have been completed on the Arizona Strip since the Powell Plateau survey: Jenkins' (1981) study of defensive Anasazi sites along the lower Virgin River and Jones' (1986a) study of agricultural features on the Walhalla Plateau. Jenkins examined the hypothesis that certain lower Virgin River sites were constructed for defensive purposes. To test this hypothesis, he selected one site for intensive analysis and conducted a survey of the river corridor 2 miles up and downstream from the site so he could compare architectural features, site layouts, and local settlement distributions. Prior to the excavation of Cliff's Edge Pueblo, AZ:A:1:30 (ASM), Jenkins outlined a series of site attributes that he believed indicative of a defensive orientation. Jenkins found that Cliff's Edge exhibited some defensive attributes (e.g., high elevation relative to nearby contemporary sites, restricted access, panoramic view) but lacked several others such as a protected site layout and evidence for military preparedness. He concluded that Cliff's Edge was defensible, although he could not demonstrate that it was settled primarily for defensive reasons. In addition to the theoretical aspects of the study, Jenkins' thesis contributed substantial information on PI material culture and PI-PII settlement patterns along the lower Virgin River.

Jones' (1986a) research on agricultural systems on Walhalla Plateau involved a two-stage random sample and quadrat survey similar to the one employed on Powell Plateau. Using Vivian's (1974) model of prehistoric agricultural intensification as a response to environmental variability, Jones developed a set of testable hypotheses concerning the size, type, efficiency, and integration of water control systems within the study area. She found that the agricultural systems on Walhalla Plateau were dominated by linear borders. The efficiency of this basic system was enhanced by the use of checkdams and gridded borders. The degree of integration was examined using the variables of site differentiation, spatial dispersion, and maximum area of land use as proxy measures. Nearest neighbor analysis of sites within one survey quadrat delineated several clusters of small, one to two room structures surrounding a unit pueblo. Measurements of areas directly affected by the water control features revealed that slightly less that 10 percent of the quadrat area was actually farmed. Jones concluded that the data did not support the idea of a highly integrated or hierarchically organized regional population oriented towards the large scale maintenance of an integrated water control system. Rather, the relatively large distance between sites and the existence of several distinct site clusters (single habitation units surrounded by several field structures) suggested that the highest order of social integration consisted of the nuclear or extended family unit.

Jones recognized that the weakest point in the analysis was her inability to control for contemporaneity between sites and site clusters. Ceramics were sparse at most sites, so microseriation of datable types was not a viable option. The assemblage at most sites indicated occupation some time between A.D. 1050 and 1150. The possibility of sequential site abandonments and relocation at various intervals within this 100 year period due to soil depletion or other environmental factors was acknowledged but could not be adequately controlled. This problem, of course, is characteristic of settlement pattern studies in general. Overall, Jones' research provides a useful analysis of the social and environmental factors affecting prehistoric settlement on the Walhalla Plateau. Furthermore, it complements nicely the earlier work on the Powell Plateau, and provides a sound basis for comparing settlement patterns in these two North Rim localities.

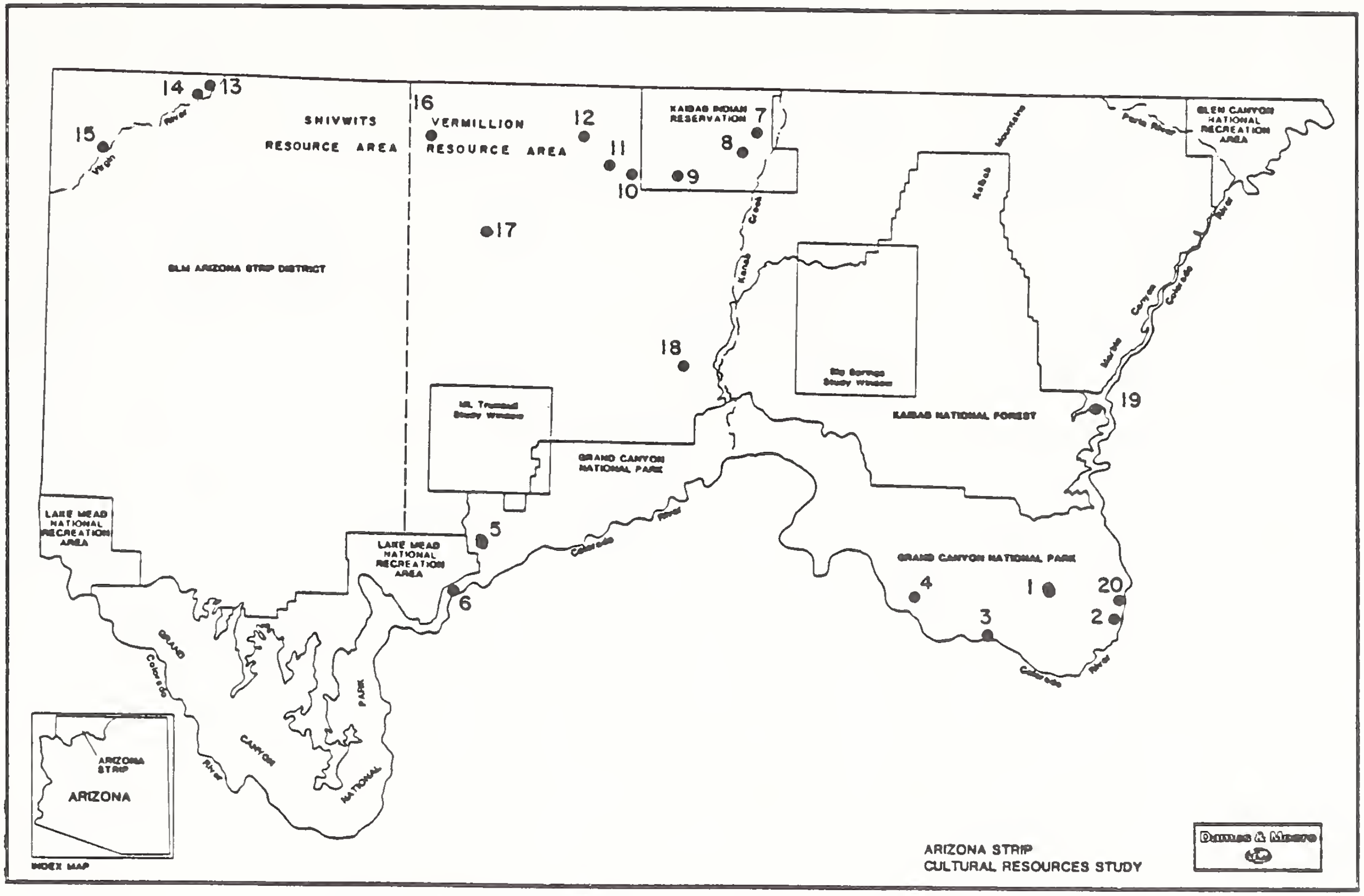
Although academic research projects have made important contributions to the data base in recent years, cultural resource management concerns continue to play a crucial role in promoting research on and adjacent to the Arizona Strip. Important excavation projects recently conducted to the north of the Arizona Strip include the Kanab Site (Nickens and Kvamme 1981), Red Cliffs (Dalley and McFadden 1985), and the Quail Creek Reservoir Project (Walling et al. 1986). The BLM-sponsored excavations at the Kanab site produced significant information pertaining to Basketmaker III and PII subsistence and architecture (Nickens and Kvamme 1981); its contributions to the data base on ceramic chronology and Virgin Anasazi subsistence are additionally noteworthy. Excavations at the Red Cliffs Site, a PI-PII habitation and storage site east of St. George, Utah, produced significant information on lowland riverine adaptations in the Virgin area (Dalley and McFadden 1985). The Quail Creek Reservoir Project, west of Hurricane, Utah, resulted in the testing of 31 sites and full-scale excavation of 18 others. These sites, representing Pueblo I and II Virgin Anasazi and Southern Paiute occupations, produced a wealth of chronological, architectural, palynological, and macrobotanical information (Walling et al. 1986). A major contribution of the latter report was the extensive discussion and reevalution of Virgin Anasazi ceramic typology authored by Richard A. Thompson.

Within the Arizona Strip, a 1983 survey of a 32-mile-long, 60-meter-wide right-of-way corridor along Highway 67 between Jacob Lake and the North Rim entrance station recorded 20 sites dating to the middle late Archaic and mid-to late PII periods (Fairley et al. 1984). The sites were interpreted as specialized activity loci and temporary camps related to late summer and fall hunting and gathering activities on the interior of the plateau. The authors used the survey data to evaluate Abbott's model of prehistoric settlement on the Kaibab Plateau. Although Abbott's emphasis on the exploitation of large game as the central focus of prehistoric activities on the plateau was supported by the survey data, the relative importance of plant resources (as evidenced by the frequency of grinding implements) was found to have been underemphasized in the original model (Fairley et al. 1984:81). The excavation of several of these sites by PIII Associates during the summer of 1987 promises to contribute valuable information on the preceramic occupation of the Kaibab Plateau, as well as providing data on Anasazi use of the plateau interior (Schroedl et al. n.d.).

Much of the current work on the Strip has been prompted by an increase in uranium exploration and mining activities. Disregarding the dozens of small drill pad surveys, some of the more significant projects resulting from energy development include the intensive survey of several lengthy road, power, and seismic line corridors (Lange and Murphy 1982; Davis 1982a; Huber 1982; Westfall 1987a), controlled surface collections and limited testing of artifact scatters (Bond 1982; G. Brown 1982a, 1982b; Davis and Westfall 1982; Davis 1982b), and data recovery at one structural site (Westfall 1987b). The projects involving controlled collection and excavation are particularly important because they provide detailed information on lithic technology, subsistence, and Puebloan architecture from previously neglected areas in the central portion of the Arizona Strip(Figure 30).

The report on the excavation of AZ B:6:44, the Pinenut site (Westfall 1987b), is an especially valuable contribution to Arizona Strip archaeology. Incredibly, this is the first major excavation project on the Arizona Strip outside of Grand Canyon National Park to be fully reported in a formal publication. The report contains a wealth of data relating to Virgin Anasazi subsistence, technology, and architectural patters.

The site consists of a masonry surface structure containing four slab-floored storage rooms with an oval habitation room appended to the east end, and a shallow, subrectangular pit structure to the south. Of the eight radiocarbon dates obtained from the Pinenut site, four clustered in the mid-to late 1200s (1235 $\pm$ 55 to 1290 $\pm$ 60) and two clustered in the late 1000s (1090 $\pm$ 90 and 1080 $\pm$ 60). Westfall (1987b:91) interprets the radiocarbon dates from the Pinenut site to indicate that there were three occupational episodes represented in the architectural remains at the site. The earliest occupation, during the mid-Pueblo II period (ca. A.D. 1050-1100), was represented by a single pithouse, two storage rooms, and a cist. During the later occupations, which she places in the mid-to late thirteenth



1) Walhalla Plateau (Schwartz et al. 1981)
2) Unkar Delta Schwartz et al. 1980)
3) Bright Angel (Schwartz et al. 1979)
4) Tuna Creek Site AZ:B:15:7 (Jones 1986b)
5) Tuweep Valley (Thompson and Thompson 1974)
6) Whitmore Wash Site AZ:A:16:1 (Jones 1986b)
7-15) Highway 395 Excavations (Wade 1967)
16) Rock Canyon Shelter (Wilde 1986)
17) Antelope Cave (Janetski and Hall 1983)
18) Pinenut Site AZ:B:6:44 (Westfall and Davis nd)
19) Stanton's Cave (Euler et al. 1985)
20) Furnace Flats (Jones 1986b)

Figure 30. Locations of Excavated and Tested Sites on the Arizona Strip.

century, the pithouse was abandoned and a large ovoid surface room was appended to one end of the masonry surface unit. During the last occupation, also during the late 1200s, the ovoid habitation room and two storage structures were reused. Although this interpretation accords fairly well with the radiometric and architectural data, other interpretations are possible. For example, Westfall rejects the validity of the earliest date at the site, A.D. 980 ± 80, which came from the large ovoid surface habitation room, even though it overlaps with the 95 percent confidence interval of the two other eleventh century dates from the site, because one post A.D. 1100 pottery sherd was present on the floor of the stucture (Westfall 1987b:94). The possiblity that this room was initially used in conjunction with the pithouse (perhaps as a kitchen), then was cleaned out and reused during the later occupation is not considered.

The tight cluster of mid-to late thirteenth century dates has important implications for the interpretation of Arizona Strip prehistory. If these dates do not represent reoccupation of the site by Paiutes (and there is absolutely no artifactual evidence to indicate this), then the commonly accepted idea of a wholesale Anasazi abandonment of the Arizona Strip during mid- twelfth century must be reconsidered. As noted by Westfall (1987b:94), the growing number of post A.D. 1200 radiocarbon dates from Anasazi sites in the Arizona Strip and southwestern Utah (G. Brown 1982a; Jones 1986b; Thompson and Thompson 1974; Walling et al. 1986) lend support to the idea (Thompson and Thompson 1974) that there was continued occupation of certain localities by the Anasazi well into the thirteenth century. If so, then current assumptions about Virgin Anasazi ceramic chronology, Anasazi-Paiute interaction, and a host of other research issues are clearly in need of re-evaluation.

The federal government's growing concern over the continuing destruction of cultural resources by human and natural agencies has stimulated several recent salvage excavations in and adjacent to the Arizona Strip. Continuing destruction of the partially excavated deposits in Antelope Cave prompted the BLM Arizona Strip District to contract with Brigham Young University for an assessment of the site's integrity and research potential. Test excavations revealed that a few small portions of the deposits remained undisturbed and BYU archaeologists recommended salvaging these remains (Janetski and Hall 1983); a report of the second phase of work is still in progress but the data recovered to date has already expanded our understanding of Anasazi culture history and adaptation in the central portion of the Strip. For example, C-14 dating of a Basketmaker-style atlatl fragment suggests that Basketmaker hunters were exploiting the area by the third century A.D., and radiocarbon dating of corn cobs suggests that farming activities took place in the immediate vicinity of the cave between A.D. 680-980. Other lines of evidence indicate that the heaviest residential use of the cave occurred during the Pueblo I period, rather than in Pueblo II times as earlier reports implied (e.g., Moffitt et al. 1978:167). Subsistence data derived from pollen and macrobotanical analyses of coprolites indicate a broad-based subsistence focus throughout the occupation of the cave (Janetski and Hall 1983:47-48).

In 1984, BYU also conducted salvage excavations at Rock Canyon Shelter (Wilde 1986). Although badly disturbed by pothunters, the shelter produced evidence of a late Archaic utilization radiocarbon dated between 4000 and 1200 B.P. (Wilde 1986). A final report on this work is in progress.

Perhaps the most significant archaeological project in recent years was an NPS sponsored testing and stabilization program at five sites along the Colorado River in Grand Canyon National Park (Jones 1986b). Three of the sites were located on the north side of the river: AZ:C:13:10 (ASM), a sizable multicomponent Anasazi habitation site upstream from Unkar Delta; AZ:B:15:7 (ASM), a rockshelter with a stratified midden in the middle reaches of Tuna Creek; and AZ:A:16:1 (ASM), another sheltered, stratified midden site upstream from the mouth of Whitmore Wash. Work at the two rockshelters involved excavating by natural levels along the exposed eroding edge of the middens, creating vertical profiles of the deposits, which were subsequently stabilized with walls constructed of locally available materials. The midden at Tuna Creek produced evidence of Basketmaker II-III, mid-PII, and post-A.D. 1300 Paiute occupations. The Whitmore Wash midden included late thirteenth century Paiute, early to mid-PII Anasazi, and late Archaic levels. The Paiute, Basketmaker, and Archaic occupations were verified with radiocarbon dates. In addition to the chronometric data, the recovery of perishable artifacts, faunal, and botanical remains added considerably to the current data base on prehistoric plant and animal utilization within the Grand Canyon.

The approach followed at the Furnace Flats site (AZ:C:13:10) was more along the lines of a traditional salvage excavation, because natural erosion was too severe to be halted by stabilization. Although only a small portion of the site was actually excavated, a considerable amount of information was recovered. The excavations revealed a complex of slab-lined storage structures, a deep, masonry-lined kiva, and several masonry rooms. The fill of one large room contained over 50 pieces of groundstone, plus pendant fragments of travertine and several fragments of unfired pottery vessels indicative of local manufacturing activities. Ceramics indicated that the site had been occupied from PI through early PIII times, with the principal occupation during PII. Ceramic dating of the deposits was supported by a carbon sample from the kiva ash box, which yielded a corrected date of A.D. 1018 $\pm$ 150. Two other radiocarbon dates from the site suggested that a post-A.D. 1300 occupation may also have occurred. A principal contribution of this excavation was the recovery of numerous flotation and pollen samples. The pollen and macrobotanical analyses supplemented the previous SAR studies at Unkar Delta, and supported the conclusion that in addition to the traditional domesticated food crops of corn and squash, wild foods such as mesquite, cacti, and weedy annuals were important components in the local Anasazi diet.

Summary of Previous Archaeological Research

The study of Southwestern archaeology was still in its infancy during the late 1800s and early 1900's. Like most Southwestern archaeological studies of this period, the early surveys and excavations on the Strip were primarily geared towards the recovery of prehistoric artifacts and descriptions of architectural remains. Sites were simplistically attributed to ancestors of the Hopi Indians in northeastern Arizona, and the Arizona Strip materials were routinely compared with those of the better known Four Corners/San Juan region. Interpretations were limited by a lack of chronological control. Research efforts were oriented toward the documentation of Pueblo period remains, and little or no attention was paid to sites lacking architecture and ceramics.

The delineation of a regionally specific Virgin Anasazi tradition and the recognition of a pre-Puebloan Archaic occupation were the major contributions to Arizona Strip archaeology between 1920 and 1965. These developments were not unique to the Arizona Strip, but reflected trends within the field of Southwestern archaeology in general. The recognition of a regional variant of the Anasazi culture encompassing the entire Arizona Strip as well as portions of southwestern Utah and southeastern Nevada was a direct outgrowth of ongoing efforts during the 1930s to organize prehistoric cultural manifestations within the Southwest into a coherent classificatory framework (Gladwin and Gladwin 1934; Colton 1939). Following the work of Aikens (1965, 1966), archaeologists debated the validity of the Virgin Branch as a regional variant separate and distinct from the neighboring Kayenta branch. This issue continues to be a subject of controversy.

Nusbaum's excavations at Cave Dupont provided the first documentation of Basketmaker II utilization of the area adjoining the Arizona Strip. Despite the lack of absolute dating methods in the early 1920s, the similarity of the Cave DuPont materials to artifactual assemblages recovered from well stratified contexts in northeastern Arizona (Kidder and Guernsey 1919) provided clear evidence of its relative temporal placement within the Anasazi developmental sequence. Harrington's excavations at Gypsum Cave in southeastern Nevada provided the first evidence of a pre-Anasazi occupation in the vicinity of the Arizona Strip. Although Harrington's interpretation of a late Pleistocene occupation level at Gypsum and Etna Caves was not borne out by subsequent studies, these early findings prompted others to look for evidence of pre-Anasazi occupation in and around the Arizona Strip. The first firm evidence of pre-Anasazi occupation in the Arizona Strip region came from several caves located north and south of the Colorado River in the inner Grand Canyon. Radiocarbon dating of split twig figurines recovered at these sites produced a series of consistent radiocarbon dates ranging between 1,000 and 2,000 B.C.

By the mid-1960s, a basic cultural historical outline encompassing the period from approximately 2,000 B.C. to A.D. 1850 was established. This framework was rudimentary, and numerous geographical and temporal data gaps remained in the record. Only the most fundamental aspects of the Anasazi occupation sequence were generally agreed upon. Knowledge of the occupation sequence prior to 2,000 B.C. was virtually nonexistent, while the post Anasazi period was primarily known from historical records rather than archaeological data.

Beginning in the late 1960s, several localities within the Arizona Strip were intensively examined for the first time. Several of the areas selected for intensive examination, such as the House Rock Valley-Paria Plateau and Toroweap-Mount Trumbull regions, had been the subject of brief reconnaissance expeditions during the 1920s and 1930s, and portions of the Walhalla Plateau had been intensively surveyed. Therefore, a basic understanding of these localities was available to archaeologists prior to the initiation of later intensive surveys. The investigations of the late 1960s and early 1970s contributed significantly to knowledge of the Anasazi occupation. The Mount Trumbull survey was noteworthy in this regard because it represented the first attempt to interpret settlement data in relation to enviromental variables using probabilistic sample survey data.

It was not until the early 1970s that cultural resource management concerns prompted archaeological investigation in the poorly known central and western areas of the Strip. Investigations along the Navajo-McCullough transmission line corridor and in the Grand Canyon Adjacent Lands study area revealed evidence of an extensive late Archaic and Paiute presence in addition to Puebloan period remains. Furthermore, the results of these studies indicated a strong orientation towards hunting and gathering during all periods. During the mid-1970s, the development of cultural resource management programs with associated permanent managerial positions on the Kaibab National Forest and at Grand Canyon National Park helped to further archaeological knowledge of several previously unstudied areas in the eastern part of the Strip. The interior portions of the Kaibab Plateau were investigated for the first time, revealing extensive use of the uplands for hunting and gathering purposes. Survey of the lower elevations surrounding the Kaibab uplands indicated that sites with structures tended to be concentrated in the pinyon-juniper zone along the flanks of the plateau. An NPS- sponsored research survey undertaken in the late 1970s indicated that on the Powell Plateau, in contrast to both the Kaibab and Walhalla plateaus, year-round habitation occurred during the period from A.D. 1050 to 1150.

Energy-related developments and concern over the continuing deterioration of archaeological resources from natural and human agencies have provided the major impetus for archaeological investigations on the Arizona Strip in the 1980s. The most significant investigations during the past few years have involved the testing of several stratified sites in the inner Grand Canyon, testing and controlled surface collection of lithic sites on the Kaibab and Kanab plateaus, the excavation of a small, late PII habitation site at the Pinenut Mine, and the salvage excavation of two stratified cave sites on the Uinkaret Plateau. Each of these projects has provided additional details concerning late Archaic and Puebloan subsistence and material culture that allow for continuing expansion and refinement of models dealing with prehistoric adaptive strategies on the Arizona Strip.

ETHNOHISTORIC AND ETHNOGRAPHIC RESEARCH

Beginning with the pioneering explorations of the Spanish padres, Dominguez and Escalante, the aboriginal inhabitants of the Arizona Strip have been the focus of considerable ethnographic study. Escalante recorded a wealth of information concerning the appearance, behavior, material culture, and subsistence practices of the aboriginal peoples encountered in Utah and the Arizona Strip. The Spanish friar noted the presence of agricultural fields and the locations of aborginal camps, trails, and watering holes. Furthermore, he kept accurate logs of their daily travels and recorded detailed descriptions of the country they traversed, so that it was possible to retrace their route and the positions of the various bands they encountered with considerable accuracy (Bolton 1950; Warner and Chavez 1976). The Spanish padres were primarily interested in learning about the aboriginal inhabitants of the area to assess their potential for conversion to Christianity. For example, they always noted whether horticulture was practiced by the various groups they encountered, because they considered agriculturalists to be more civilized and hence more able to accept the Christian faith. Although motivated by spiritual rather than scholarly concerns, Escalante's attention to geographical and cultural details resulted in an invaluable compilation of data concerning eighteenth century Southern Paiute culture.

The traders, trappers, and miners who followed in the padres' footsteps were generally uneducated, semiliterate entrepreneurs. Their primary interests lay in opportunistic exploitation of the country's natural resources, including beaver pelts, metal ores and occasionally, human slaves. Some of these men did record their travels in writing, but many of the journals from this period are too vague to permit accurate reconstructions of the places or people encountered. There are a number of notable exceptions, however, including the journals of Jedediah Smith, who passed through the northwestern corner of the Strip along the Old Spanish Trail in 1826 and 1827 (Sullivan 1934; Morgan 1953; Morgan and Wheat 1954), and the published account of the Spanish trader, Antonio Armijo, who in 1830 attempted to take a shortcut to Califonia from Abiquiu, New Mexico by retracing the route of the Dominguez-Escalante expedition across the Arizona Strip (Hafen and Hafen 1954). Following the military defeat of Mexico and the annexation of New Mexico Territory in 1848, a United States military expedition under the command of Lt. John C. Fremont passed through the region. Close on their heels came wagonloads of immigrants and gold miners in route to California. Most immigrants and miners followed routes to the north or south of the Arizona Strip, but a few followed the Old Spanish Trail. Then, beginning in the early 1850s, Mormons established settlements in southwestern Utah. Many members of these groups made passing mention of the region's aboriginal inhabitants, their lifestyle, customs, and appearance, although these observations frequently reflected ethnocentric attitudes and played up to the author's particular audience (i.e., military commanders in Washington, D.C., armchair adventurers, or church elders). Despite such failings, these early documents provide significant insight regarding the early historic Native American occupants of the Arizona Strip and adjoining regions. A comprehensive collection of early historic references pertaining to the Southern Paiute can be found in Euler (1966) and Manners (1974); both of these ethnohistoric studies of Southern Paiute culture are discussed in greater detail below.

Although many of the early references to Southern Paiute culture have proved of value to later scholars, no records were collected explicitly for research purposes prior to 1869. In that year, John Wesley Powell undertook the first ethnographic studies among the Southern Paiute. Powell's involvement with the geological and geographical survey of the Strip country precluded intensive study of Southern Paiute culture, but whenever his fieldwork brought him in contact with Native Americans, he took full advantage of the opportunity to collect additional ethnographic data. His fieldnotes encompass a wide range of anthropological interests: lists of vocabulary and kinship terminology, translations of myths and songs, notes on curing rituals, subsistence, leadership roles, and material culture. Powell also acquired an extensive collection of material culture items, which he catalogued according to tribe and function.

Most of Powell's work among the Southern Paiutes of the Arizona Strip was conducted in the winters of 1869-1870 and 1871-1872, following the first exploration of the Colorado River and during an extended break in the second expedition. In 1873, Powell was appointed Special Commissioner of Indian Affairs and in the late spring of that year, Powell, G.W. Ingalls, and John K. ("Jack") Hillers, a member of the second Powell expedition, traveled to the west to investigate the condition and needs of the various Indian groups inhabiting the Great Basin and the Colorado Plateaus. Part of their reconnaissance involved a two month journey across the Strip during July and August, visiting and talking with the native and Mormon inhabitants. A report was submitted to Congress the following year (Powell and Ingalls 1874). Powell apparently intended to publish a comprehensive ethnography on the "Numa," his term for the Numic speaking tribes of the Great Basin and western Colorado Plateau, but time and other obligations prevented him from accomplishing this goal. In recent years, Powell's voluminous notes, correspondence, and an unfinished manuscript on the Numa have been compiled and edited by Fowler and Fowler (1971a). This book includes a reprint of the Powell and Ingalls report, as well as a brief biographical sketch of Powell and a summary of his ethnographic contributions. An overview of Powell's anthropological work in the Grand Canyon region is presented in Fowler et al. (1969). Fowler and Matley (1978) have analyzed and photographed Powell's collection of Numic artifacts housed at the Smithsonian Institution. In combination, these three articles provide a comprehensive summary of John Wesley Powell's pioneering contributions to Southern Paiute ethnography on the Arizona Strip.

Powell was not the only member of his expedition to collect notes on the Southern Paiute. The diaries of his men contain occasional references to their interactions with Southern Paiute bands (Darrah 1947; Darrah et al. 1948-1949). Frederick Dellenbaugh was particularly fascinated by the aboriginal culture and his notes (Euler 1966:Appendix 1), letters (Crampton 1969; Jones 1948), and popular accounts of the second Powell expedition (Dellenbaugh 1962, 1984) contain brief but noteworthy observations on the Southern Paiute. Jack Hillers, in his capacity as photographer for the Powell expedition, recorded a wealth of information pertaining to the Paiutes' physical appearance, material culture, architecture, and environment (Fowler 1972). Unfortunately, many of the photographs depict Southern Paiutes wearing Northern Ute clothing (Steward 1939; Euler 1966:Appendix I). These images were apparently produced for commercial consumption and reflect Powell's attempts to make the Southern Paiutes conform to eastern ideals of the American Indian while at the same time avoiding offense to Victorian sensibilities regarding nakedness.

Other military and civilian geographical surveys that operated in Utah and the Great Basin region during the mid-1800s contributed information on the aboriginal occupants of the territory (Ives 1861; Simpson 1876; Wheeler 1872, 1875, 1889; Whipple 1856). Several reports dealt exclusively with the Indian tribes of the region (e.g. Hoffman 1878; Whipple et al. 1856). These reports do not deal explicitly with the Southern Paiute on the Arizona Strip, but they do include references to the Chemehuevi Paiute living along the upper Colorado River and the various Southern Paiute bands living around Las Vegas Springs, along the Muddy River and Ash Creek in southeastern Nevada, and along the Virgin and Santa Clara Rivers in southwestern Utah. Therefore, they provide a basis for comparing the early historic lifestyles of various segments of the Southern Paiute population within the Basin Plateau region as a whole.

Edward Palmer, a contemporary of Powell's and a self-trained natural historian, traveled extensively throughout the west collecting botanical, ethnobotanical, archaeological, and ethnographical specimens, which he sold to various museums and research institutions. His clients included the Smithsonian Institution and the Peabody Museum at Harvard University. Palmer carried out ethnobotanical research among the Southern Paiute of southern Utah and the Arizona Strip in 1870 and again in 1875-1876, and during these trips, he also made collections of ethnological and archaeological artifacts. Most of Palmer's work during the 1875-1876 season concentrated in Washington and Kane counties, Utah. Specimens collected by Palmer on the first expedition were deposited with the Peabody Museum, while the materials from the second were divided between the Peabody and the Smithsonian Institution. Palmer's ethnobotanical samples at the Peabody Museum have been studied and identified by Bye (1972), and the 1,875 ethnological and archaeological specimens housed at the Smithsonian have been analyzed and reported on by Fowler and Matley (1978). Palmer also kept miscellaneous notes on the aboriginal peoples he encountered, and some of those dealing with the Numic speaking people of Utah have been published (Heizer 1954).

The first systematic anthropological study on the Arizona Strip was conducted in 1910 by Edward Sapir. Sapir was primarily concerned with Southern Paiute language, but he also collected miscellaneous ethnographic information in conjunction with his linguistic studies (Sapir 1910a, 1910b). His informants included members of the Shivwits and Kaibab Paiute bands. Sapir's publications on Southern Paiute language appeared many years after completion of his fieldwork (1930, 1931).

Following Sapir's investigations, several ethnographic studies were conducted among the Shoshonean and Yuman-speaking people of the Great Basin and Colorado Plateau (Kroeber 1935; Lowie 1924; Spier 1928). Although these studies did not focus specifically on the Southern Paiute, they did include references to the Paiute of southeastern Nevada, southwestern Utah, and the Arizona Strip, and frequently used the Paiutes as a point of comparison with their primary subjects. Thus, these ethnographies contribute indirectly to a broad understanding of Southern Paiute culture.

Sapir's ethnographic notes provided a foundation for Isabel T. Kelly's Southern Paiute Ethnography (Kelly 1964). Kelly's ethnographic research focused on the relationship between Southern Paiute habitat and subsistence strategies in the mid- 1800s (1964:2), but she collected a wide range of anthropological data pertaining to Southern Paiute culture in general. Fieldwork for the study was initiated in 1932. Kelly spent two months among the Kaibab Paiute at Mocassin, Arizona, where remnants of the Kaiparowits band were also in residence. The rest of her time was divided among the Shivwits on the Santa Clara reservation near St. George, the Las Vegas Moapa Paiute on the Moapa Reservation in southeastern Utah, and with isolated representatives of the Panguitch and San Juan Paiute bands in Cedar City, Utah, and Tuba City, Arizona, respectively. The Uinkaret Paiute were extinct by this time.

Shortly after completion of fieldwork, an article dealing with one facet of her research, Southern Paiute band territories, appeared in American Anthropologist (Kelly 1934). In that article, Kelly defined Southern Paiute bands as "dialect units with political concomitants," a controversial approach in the eyes of later scholars (e.g., Steward 1938:236; Manners 1974). Kelly maintained that this definition of Southern Paiute bands was validated by the consistency with which various informants defined the territorial limits of their own dialect group versus those of neighboring groups.

A manuscript on Kelly's primary research topic was partially written in 1933 and 1934 but remained unpublished for 30 years. In 1964, as a direct outgrowth of the Glen Canyon archaeological and historical studies, Kelly agreed to publish the manuscript, with minor editing, in its unfinished form. By Kelly's estimation, this manuscript included about one third of the data collected in 1932 (Kelly 1964:iii-iv). Kelly's Southern Paiute Ethnography continues to be the main reference for mid-nineteenth century Southern Paiute culture. This report contains a wealth of information on the Kaibab Paiute occupants of the eastern Arizona Strip. Data on social and economic structure, technology, subsistence, interband exchange, and material culture are included, as are less detailed accounts of neighboring Paiute bands to the north and east of the Kaibab Paiute. Unfortunately, Kelly's study deals only with four eastern Paiute bands, so comparable information on the Uinkaret and Shivwit Paiutes is not available. Some ethnographic information on the western bands can, however, be gleaned from Kelly's (1934) article on Southern Paiute territorial divisions and from Kelly and Fowler's

(1986) chapter in the recent edition of Handbook of North American Indians: Great Basin (Volume 11).

As noted above, Kelly's primary research interest concerned Paiute subsistence in relation to habitat. Kelly documented seasonal mobility of the Kaibab Paiute in considerable detail, noting the locations of base camps, important water sources, areas favored for gathering specific plant resources, and communal hunting territories. She collected detailed information on the seasonal activities carried out at various locations within the band's territorial range. Because her data for the other three eastern bands is less complete and information on the western bands is lacking, Kelly's reconstruction of Kaibab Paiute seasonal transhumance serves as the primary model for Southern Paiute subsistence systems on the Colorado Plateau.

Recently, Kelly's study has found a following among archaeologists working in the Arizona Strip and adjoining areas of Utah and Nevada (e.g., Abbott 1979; Janetski and Hall 1983; Westfall 1986). Not only does it provide a useful model for investigating Paiute archaeology, but it can also serve as a de facto model of Archaic period hunting and foraging systems. The applicability of Kelly's model to Archaic and prehistoric Paiute manifestations is examined elsewhere (see Chapter 4).

Concurrent with Kelly's work among the Southern Paiute, Julian H. Steward initiated research among the Shoshonean speaking peoples of the Great Basin and Columbia Plateau. In 1938, he published the results of his investigations in a volume entitled Basin Plateau Aboriginal Sociopolitical Groups (Steward 1938). Steward argued that the ecological parameters of the Great Basin Plateau environment determined the structure of aboriginal Shoshone culture. He theorized that the arid and unpredictable environment of the Great Basin, coupled with the technological level of the culture, had a fragmenting effect upon Shoshone society, which restricted development of traditional social institutions beyond the nuclear family level. Steward explored the role of the environment in influencing all aspects of the culture, including population density; size, mobility, and distribution of settlements; economy; and material culture. Steward's study built upon his earlier work in the newly developing field of human ecology (Steward 1936) and rapidly gained widespread recognition as a pioneering approach to the study of man's relationship with his environment. Although some of Steward's ideas have been challenged in recent years, particularly in regard to Steward's concept of the "family band" as the basic social unit of Great Basin Shoshonean society (c.f. Service 1962) and the nature of Shoshonean territoriality (c.f. Stewart 1966), his work was one of the most influential studies in anthropology and continues to serve as a model of human adaptation in an arid environment.

In 1937 and 1938, Omer C. Stewart undertook field investigations among the Southern Paiute, Ute, and Navajo of the Colorado Plateau province as part of a nationwide study aimed at compiling a comprehensive list of Native American cultural elements. Stewart's primary goal was to collect information on aboriginal cultural traits prior to A.D. 1850. In theory, these traits encompassed all the material and behavioral aspects of an entire cultural system. In conjunction with this work, Stewart also gathered miscellaneous ethnographic data, which he incorporated into the final study. His list of Southern Paiute culture elements (Stewart 1942) provides brief descriptive data on a wide range of topics, some of which were only touched upon by Kelly. Unfortunately, the data cannot be accepted as an unequivocal record of aboriginal Southern Paiute culture due to the fact that they were gathered almost 90 years after initial white contact.

In 1946, the United States Congress created a judicial tribunal to hear and settle all claims by native American tribes regarding unfulfilled treaty obligations and illegal disposal of Indian lands by the federal government. In an effort to determine the validity of the various claims, the Indian Claims Commission compiled voluminous data from a wide variety of sources, including many previously unpublished anthropological studies. In addition, a number of anthropologists were hired by the government and the claimants to compile ethnohistorical and archaeological information to support or refute the Indians' territorial claims. Among the documents compiled for the Paiutes' litigation were

Kelly's previously described unpublished manuscript and two syntheses of the ethnohistorical literature on Southern Paiutes, one by Manners (1974) and a second by Euler (1958).

Manners' ethnohistorical report focused primarily on the sociopolitical organization of the Southern Paiute. Manners objected to the use of the terms "tribe" or "band" in referring to Southern Paiute social organization, because he found no evidence to support the existence of any formalized, intergroup cooperative structure above the nuclear family unit. He buffered his arguments with descriptions of the aboriginal environment, subsistence strategies, and technology as revealed by the ethnohistorical literature. Basically, his position reiterated that of Steward (1938), namely that the environmental and technological constraints within which the Paiute operated did not permit the formation of sociopolitical structures beyond the family level.

Euler's (1958) ethnohistorical study, originally compiled for the Indian Claims Commission, was later expanded (with a section on environment by Catherine S. Fowler) and included in the Glen Canyon series (Euler 1966). Like Kelly's early publication, Euler's study was necessitated by the paucity of archaeological data pertaining to the Southern Paiute occupation of the Glen Canyon region. Although historical documents contained numerous references to Paiutes in the Glen Canyon area and a few Paiute sites were documented in the archaeological descriptive reports (e.g., Fowler et al. 1959; Gunnerson 1959:159; Adams et al. 1961:13 and 24), this aspect of the Glen Canyon archaeological record was not accorded much attention.

In fairness to the investigators, it must be understood that during the late 1950s and early 1960s, when the Glen Canyon project was underway, recognition of Paiute archaeological remains was hampered by a lack of information concerning diagnostic material culture traits other than pottery. The Paiutes did not typically construct substantial architectural features and most of their material culture consisted of perishable items constructed of plant fiber and hide, which are only preserved under the most favorable circumstances. Ethnographic artifacts collected by Powell, Palmer, and others had not yet been studied in detail, so there was no way to positively identify articles of Paiute manufacture when such items were encountered. Projectile point typologies had not yet been developed for the Glen Canyon region, so the recognition of Paiute sites in the absence of pottery was virtually impossible. Because so little could be gleaned from the archaeological record, Euler and Fowler sought alternative means to address the problem. Initially they attempted to use living informants to help them identify known Paiute sites, in hopes that this information would allow them to extrapolate backwards in time (Sweeny and Euler 1963). When it became apparent that few Paiute informants had any detailed knowledge concerning their former way of life, this approach was abandoned. Euler subsequently turned to the historical literature in an attempt to reconstruct Southern Paiute culture at the time of initial European contact. Drawing upon a diverse assortment of primary and secondary documents, he assessed the historical reliability of each source in turn and then judiciously separated the valid ethnographic data from the hyperbole. Unlike Manners' study (of which Euler was apparently unaware), Euler was concerned with the full range of Southern Paiute culture at the time of initial European contact. He was mainly interested in describing the pre-contact conditions and in documenting the types and extent of acculturation experienced by the Southern Paiute as a result of the European incursions.

By the late 1950s, the focus of ethnographic research on the Arizona Strip turned away from reconstructions of aboriginal subsistence settlement adaptation to other topics. Perhaps in part because Sapir's thorough linguistic research early in the twentieth century provided a solid foundation for later studies, a seemingly disproportionate amount of research among the Southern Paiute has focused on linguistics (Lamb 1958; Goss 1965; Fowler 1972; Bunte 1979). Of particular importance to cultural historical reconstructions on the Arizona Strip is the glottochronological and geographic evidence compiled by Lamb (1958), Goss (1965), and others. Lamb's (1958) work suggests that the Numic language diverged from a common center in southeastern California around A.D. 1000 and spread rapidly across the Great Basin onto the Colorado Plateau. Goss's (1965) study on Ute language supports this reconstruction, and suggests that the Ute dialects diverged from Southern Paiute around A.D. 1300. Several archaeological studies have relied on linguistic evidence to support arguments for and against the contemporaneity of Southern Paiute and Anasazi on the Arizona Strip after A.D. 1000.

Current ethnographic research on the Arizona Strip focuses on contemporary Southern Paiute culture and language (e.g., Knack 1980; Bunte 1979). A popular summary of modern Southern Paiute culture can be found in Euler's book, The Paiute People (1972). In addition, several anthropologists have recently reworked and expanded upon the earlier studies by Kelly and others in an attempt to improve understanding of aboriginal Southern Paiute culture (e.g., Stoffle and Evans 1976; Fowler 1982).

CHAPTER 4

PREHISTORY

Helen C. Fairley

The prehistory of the American Southwest is commonly subdivided into several temporal units or periods. Although these periods are strictly chronological concepts, implications of lifeway or stages of cultural development are unavoidable. Man clearly altered his methods of survival through time, and those adaptive developments engendered or necessitated changes in technology, social organization, religious orientation, settlement patterns, and material culture. Periods are not synonymous with levels of cultural development, however, nor are they expressions of cultural uniformity within a given region. Periods are simply convenient units of time, which help organize the culture history of a region. The difference between periods and cultural units is succinctly summarized by Warren (1980:17).

> A period is a unit of time identified by the occurrence of an artifact type or types (period markers). Because it is identified by a small range of artifact types, a period may be a time when a given area was occupied by one cultural unit or several distinct cultural units. Cultural units need not conform temporally to the periods. A cultural unit may be included in one period, fall partially in two periods or even extend over two or more periods. Cultural units and time periods are independent and distinct concepts.

In contrast to a period, a phase is a temporal or developmental stage division within a specific cultural unit (Colton 1939; McKern 1939). On the Arizona Strip, the phase concept has been applied to the Virgin Anasazi culture (Harrington 1930c; Colton 1952; Shutler 1961). The use of the phase concept in this context has tended to confuse and not clarify the archaeological record of the Arizona Strip. The application of phase names to Anasazi manifestations on the Strip has tended to create an impression of regional uniformity and gradual evolutionary progression in cultural developments that is not supported by the archaeological data currently in hand. In simple terms, the present state of knowledge regarding the Anasazi or any other cultural unit in Arizona Strip prehistory is not sufficiently detailed to permit meaningful use of the phase concept.

An alternative framework involving the use of generic temporal subdivisions, rather than a sequence of regionally specific phases, is advocated for the Arizona Strip region at this time. This framework encourages the organization of archaeological data in a temporal scheme, while acknowledging the possibility of more than one contemporaneous cultural entity co- occurring in the region in any given period. As more data are collected, it may be possible to define a series of phases that have meaning for the region as a whole or for specific portions of the region, but for the time being, a more generalized approach is appropriate.

In the following chapter, the cultural history of the Arizona Strip is divided into five main temporal periods: Paleoindian, Archaic, Formative, Neo-Archaic, and Historic. These labels have been previously applied to archaeological data from adjoining portions of southwestern Utah (Thompson et al. 1983; Walling et al. 1986). Each of these periods is further subdivided on the basis of one or several temporal diagnostics, which may or may not correlate with changes in technology, subsistence settlement strategies, or other nonmaterial cultural aspects.

In the following pages, the archaeological evidence for each of these temporal periods on the Arizona Strip is discussed. The discussion of each major period begins with an introduction to the terms employed, followed by a review of the chronological evidence and archaeological constructs pertaining to that period. The culturally and temporally diagnostic attributes of each period are subsequently identified, and a synopsis of the distributional evidence pertaining to sites of that period is presented. Specific aspects of the cultural systems operating in the region during various temporal intervals are then summarized. Because the amount of information available for each period varies considerably, it is not possible to discuss each cultural system in equal detail. To the extent that the database permits, summaries of architectural patterns, technology, subsistence, settlement systems, cross-cultural interactions, and exchange are included. The discussion proceeds chronologically, beginning with the earliest cultural complex defined in the project area.

PALEOINDIAN PERIOD

The dating of the earliest human occupation in the Americas is a matter of continuing debate among archaeologists. The earliest undisputed evidence places man in the New World by 10,000 B.C. Haynes (1969) groups North American Paleoindian sites into three broad temporal categories: early, middle, and late. The first two subdivisions are poorly represented in the archaeological record and not well accepted as valid entities. In contrast, the late Paleoindian period is well represented, particularly to the south and east of the Colorado Plateaus. On the Colorado Plateaus, the earliest documented human occupants fall within Haynes' late period, which starts at approximately 9500 B.C. For the purposes of this overview, "Paleoindian" is basically synonymous with Haynes' "Late Paleoindian," although a cut off date at 7000 B.C. is used here, rather that the 5000 B.C. date proposed by Haynes.

There are four cultural complexes of the Paleoindian period -- Clovis, Folsom, Plano, and San Dieguito -- that may be relevant to the Arizona Strip. The first three are primarily a Plains phenomenon, although artifacts diagnostic of each complex have been identified on the Colorado Plateaus and in the Great Basin. The complexes are chiefly defined by differences in projectile point styles and big game preferences. The fourth complex is a poorly understood and still somewhat controversial manifestation that has been recognized primarily in the deserts of southern Arizona and California, but also extends northward along the Colorado River into southern Nevada.

In the Plains region, including southern New Mexico and southeastern Arizona, the temporal primacy of Clovis at 9500-9000 B.C. is well established, followed by the Folsom complex at ca. 9000-8000 B.C. (Haynes 1971). Although some temporal overlap between these two is evident from the radiocarbon determinations (Cordell 1979:Figure 1), differences in projectile points and large mammal preferences allow a clear distinction to be drawn. The chronological placement of the Plano complex is more problematic, perhaps in part because of the considerable diversity of point types that define the complex, each with a somewhat different temporal and geographic distribution.

Generally, the Plano complex is thought to post-date the Folsom. This view, however, depends on whether point types such as Midland and Plainview are considered as Plano or earlier. At the Hell Gap site in Wyoming (Irwin-Williams et al. 1973) Midland points were at least partly contemporaneous with Folsom points, although there was apparently some stratigraphic separation. If we limit the designation of Plano to Paleoindian point types with a restricted base, such as Agate Basin, Alberta, and those of the Cody Complex, then the Plano complex dates roughly between 8000 and 6000 B.C. Of course, all of the dates for this time period come from sites hundreds of miles from the Arizona Strip.

Western Paleoindian Complexes

The relatively well-dated Paleoindian type sequences from the Plains region are commonly applied to other areas of North America where sites with solid chronological controls are less abundant. This practice has led to the impression of a widespread contemporaneous distribution of the three main Paloeindian complexes. Recent studies (Cordell 1984:150) now suggest that the temporal and geographical distribution of the three Paleoindian complexes across North America may not be as uniform as previously supposed. Although the temporal sequence of Clovis, Folsom, and Plano points appears well established for the Plains region and southeastern Arizona, there are apparent differences to the west of the Colorado Plateau.

In the Great Basin region, Clovis and other large basally fluted points have been lumped under the heading of Fluted Point tradition (Hester 1973) or Fluting co-tradition (Davis 1978). The few points from the Great Basin, which have been classified as Folsom in the published literature, are actually more closely akin to Clovis points (Davis and Shutler 1969). Thus, it appears that the Folsom type may not be indigenous to this area. The typical toolkit of the Fluted Point (i.e., Clovis) tradition includes fluted bifaces with either parallel-sided or ovate bodies, crescents, crescentics, serrated flake cutters, lanceolate knives or preforms with square bases, keeled and bipointed "slug" scrapers, spurred end scrapers, side scrapers, spoke shaves, choppers, pounding/grinding cobbles, and a variety of beaked tools (Warren 1980:33).

Another important difference between the Plains region and the Great Basin concerns the existence of an early Stemmed Point Tradition west and northwest of the Colorado Plateau (Layton 1970). The Stemmed Point tradition appears to be at least partly contemporaneous with the Fluted Point tradition and may actually appear slightly earlier than the Clovis complex (Carlson 1983:76). The relationship between the fluted and stemmed point traditions remains unclear.

Most of the fluted points reported from the Great Basin region have been recovered by amateur collectors from surface contexts, either as isolates or from multicomponent sites, and temporal controls are lacking. Temporal placement of fluted points is largely based on morphological similarities to the well-dated Plains point types. In situ dating of stemmed points is somewhat more secure, although it is by no means solid. Holmer's (1986) brief review of the evidence indicates that the two traditions were at least partially contemporaneous, although stemmed points continued in use longer than the fluted types. Davis (1978:45-51) has postulated that the Great Basin fluting co-tradition predated the Clovis complex on the Plains and provided the cultural substratum out of which the classic (Plains) Paleoindian traditions developed. At present, however, the paucity of chronological data do not permit evaluation of Davis's hypothesis.

The Stemmed Point tradition can be considered as one facet of Davis' (1969) Western Lithic co-tradition, a widespread hunter-gatherer adaptation characterized by the following material traits: weak-shouldered, long-stemmed points, extensive production of macroflakes, large end scrapers, spoke shaves, crescents, high-domed planes, points or knives made on flakes or ovate bifaces of various sizes, choppers, absence of seed milling equipment, and frequent proximity to water sources that are currently dried up or reduced. Subsumed within the Western Lithic co-tradition are a number of regionally defined "complexes," including the commonly referenced San Dieguito complex (Warren 1967).

Late Paleoindian points with parallel oblique and parallel transverse flaking patterns, such as the Eden point and the "true" Humboldt Concave Base type (Holmer 1986), are widely distributed over the Colorado Plateau and are probably indicative of sporadic, late Paleoindian use of the area. The relationship between these Plano points and the early stemmed types, such as the Mohave Silver Lake points, is obscure. Although most Great Basin researchers consider the Mohave Silver Lake point to be part of the San Dieguito complex dating to the late Paleoindian period (e.g., Bedwell 1970, 1973; Davis 1967; Warren 1967; Layton 1972), similiar points recovered on the eastern Colorado Plateau are generally thought to be diagnostic of the early Archaic period (Irwin-Williams and Haynes 1970; Irwin-Williams 1979). Some of this confusion stems from a lack of consensus concerning the dividing point between the Paleoindian and Archaic periods, but it is in large part a result of inadequate temporal controls, imprecise type terminology, and conflicting interpretations of the archaeological data.

Both Clovis and Silver Lake Mohave points are known from the northwestern part of the Strip, so the dating of these point styles is obviously significant for intepreting the prehistory of this area. The best guess at present is that Clovis points in the Great Basin are coeval with the Clovis horizon east of the Colorado Plateaus and are more or less confined to the 9500 to 9000 B.C. period. In the vicinity of the Colorado Plateaus, the Silver Lake Mohave points and associated artifact assemblages probably date somewhat later than the Clovis horizon, ca. 9000 to 5000 B.C. Because of their apparent extended uselife, which spans both the latter part of the Paleoindian and early Archaic periods, the Silver Lake Mohave points are only considered reliable for dating sites to a generalized "early" (pre 5000 B.C.) time period.

Paleoindian Subsistence

Current understanding of the various Paleoindian traditions in terms of subsistence strategies is limited. Most excavated Paleoindian sites are kill sites and hunting camps, a bias due in part to the presence of large mammal bones, which call attention to these sites. The classic model of the "Big Game Hunting tradition," which views the Paleoindians as exclusively meat eaters whose entire way of life revolved around the exploitation of large game animals, may be in large measure a result of past emphasis on kill and butchering sites and the lithic artifacts associated with these hunting related activities. Although no consensus has been reached, the hypothesis that large game exploitation constituted only a portion of the Paleoindian subsistence schedule is currently receiving serious attention.

Bedwell (1970, 1973) and Hester (1973) consider stemmed points to be diagnostic of the Western Pluvial Lakes tradition, a poorly defined construct with an inferred adaptation centering on the exploitation of lacustrine resources. A lacustrine orientation is inferred from the relatively common occurrence of Paleoindian artifacts in surface contexts around the shores of Pleistocene lake beds. In recent years, the concept of the Western Pluvial Lakes tradition has been challenged on several fronts (Heid et al. 1979; Tuohy 1974; Weide 1976). Much like the Big Game model of the plains region, the lacustrine adaptation has been presented as though the inhabitants of the Great Basin pursued no other resources. Alternative interpretations, which view the lacustrine orientation as only one aspect of a broadly based extractive system, are more generally accepted (Davis 1969, 1978; Heid et al. 1979; Warren 1967, 1980a). Until more evidence is in hand, however, all of these viewpoints must be considered untested hypotheses.

Paleoindian Evidence on the Arizona Strip

A substantial number of isolated Paleoindian projectile points are reported from widely scattered localities on the Colorado Plateau (see reviews in Schroedl 1976; Hauck 1979a, 1979b; Nickens 1982) and in the Great Basin (Davis and Shutler 1969). In addition, a number of Paleoindian sites have recently been discovered in southeastern Utah (Geib and Bremer n.d.; Davis 1985; Davis and Brown 1986; Geib et al. 1986). One isolated Clovis point is reported from just outside the Arizona Strip, in the vicinity of Bitter Springs east of the Colorado River near Marble Canyon (Huckell 1982:13). There is currently only one published report of Paleoindian remains from the Arizona Strip proper: a Clovis-like point was found at AZ:A:1:17 (BLM) in Sullivan Canyon (Miller 1978). At least one other possible late Paleoindian site, AZ:A:1:51(BLM), has been recorded from the middle Virgin River area (BLM site files); the lithic scatter site produced two Silver Lake point fragments. In addition, there is an unsubstantiated report of Paleoindian points occurring along the North Rim in the vicinity of Tuckup Canyon (Janet Balsom, personal communication, 1987).

The paucity of Paleoindian remains on the Strip seems somewhat anomalous given the increasing evidence indicating that the Pleistocene megafauna preferred by Paleoindian hunters were present in a wide variety of ecological settings on the Colorado Plateau as late as 7500 B.C. (Agenbroad et al. 1986). This situation may be a reflection of the spotty and sporadic archaeological coverage of the area. Amateur collecting in the area may also have taken a toll. It could also be a reflection of erosion or burial of Pleistocene surfaces. Yet even considering all these factors, it seems unlikely that so few points would have been recovered by professional archaeologists if the area had been intensively exploited by Paleoindian hunters. Is it possible that the paucity of diagnostic Paleoindian artifacts reflects the upland area's unsuitability for Paleoindian exploitation strategies? This question is just one of many fundamental research issues pertaining to the Paleoindian period that remain to be addressed. Basically, we are still in a stage of documentation for this period of prehistory, which until very recently was thought by many archaeologists not to have existed on the Colorado Plateau.

ARCHAIC PERIOD

As used herein, "Archaic" refers to a temporal period extending from about 7000 B.C. to roughly 300 B.C. Despite our chronological use of the term, implications of lifeway or stage of cultural development (e.g., Willey and Phillips 1958) and material cultural attributes are inescapable. Broadly conceived, the Archaic period is characterized by a hunting/gathering lifeway, which developed over much of the Americas after the extinction of the Pleistocene megafauna and evolution of postglacial environments.

The material correlates of this adaptation that contrast with those of the Paleoindian period include greatly altered projectile point styles; relatively numerous items associated with plant food procurement and processing such as grinding slabs, milling stones, various forms of basketry, roasting pits, and storage cists; and items associated with small game procurement such as snares and nets. The contrast between Paleoindian and Archaic technology undoubtedly results from a variety of factors, including differences in subsistence orientation, different activities associated with sites of various locations, and differential artifact and site preservation.

Jennings and Norbeck (1955) initially proposed the term Desert culture to describe the hunting and gathering lifestyle of the prehistoric and historic inhabitants of the Great Basin. The Desert culture was conceived as a widespread, mobile hunter- gatherer adaptation to an arid environment that began in the Great Basin at least 10,000 years ago and continued with few modifications up to the historic period. The historic Numic subsistence strategy of intensive exploitation of a broad array of plants and animals from diverse ecological settings in a repetitive seasonal round (Steward 1938; Kelly 1964) provided the primary model for the Desert culture lifeway. Coiled and twined basketry, slab milling stones and cobble manos, rabbit fur blankets, snares, nets, atlatls and spears were viewed as the principal material culture attributes of the prehistoric Desert culture.

The Desert culture was subsequently recognized to be part of the continent-wide Archaic adaptive pattern involving the broadly based exploitation of diverse plants and animals that followed the Paleoindian period (Willey and Phillips 1958:107). The term Desert culture was ultimately abandoned in favor of Desert Archaic (Jennings 1964). More recently, the label Western Archaic tradition (Jennings 1974), has been used to identify the transhumant lifeway and artifactual assemblages specifically oriented towards the arid and semi arid environments of western North America.

As currently defined (Jennings 1974:154), the Western Archaic tradition encompasses most of the area west of the Rocky Mountains and includes several regional expressions of the general Archaic "culture." The temporal definitions of these regional variants, and even the diagnostic attributes of each variant, are by no means agreed upon. In southern Arizona, Sayles and Antevs (1941) defined the Cochise culture and divided it into three temporal developmental stages: Sulphur Springs, Chiricahua, and San Pedro. In the southern Great Basin region, the hunting-gathering seed processing adaptation following the Paleoindian period has been often equated with the Pinto Basin complex (Rogers 1939), whereas in the eastern portion of the Colorado Plateau, a contemporaneous San Jose tradition has been defined (Bryan and Toulouse 1943). In other words, at least three different archaeological constructs (culture, complex, and tradition) with three different labels (Cochise, Pinto, and San Jose) have been applied to Archaic manifestations in three major regions of the Southwest.

Recognizing a fundamental similarity between these various designations, Irwin-Williams (1967) suggested the term Picosa (an abbreviation of Pinto Cochise San Jose) be used to designate the continuum of related cultures in the Southwest after ca. 3000 B.C. Subsequently, Irwin-Williams (1973) defined an Oshara tradition which accounted for the entire sequence of Archaic manifestations in the eastern Southwest, incorporating Picosa as the final (late) Archaic stage. Although these named sequences are often cited in the published literature, there is still no general agreement concerning the application of the terms (Martin and Plog 1973:80).

Because the regional expressions of the Archaic culture are still so poorly understood, and given the likelihood that the Arizona Strip, because of its geographically transitional situation, was used by various Archaic groups with diverse origins, the generic temporal labels of early, middle, and late Archaic are used in this overview to organize the Archaic period archaeology of the area. This approach avoids the geographical "centroid" misconceptions that are invariably implied by the use of existing phase sequences or named "complexes." The dating and artifactual evidence for each of these temporal subdivisions are briefly reviewed.

Chronology and Diagnostic Temporal Artifacts

The first solid evidence of the antiquity of the Archaic period on the Colorado Plateaus came from excavations at Sand Dune and Dust Devil Caves near Navajo Mountain, Utah, which produced sandals radiocarbon dated from 5000 to 6000 B.C. (Lindsay et al. 1968). Subsequent work at Dust Devil Cave clarified the stratigraphic relationship of materials, extended the range of the Archaic occupation back to almost 7000 B.C., and provided much greater detail on technology and subsistence (Ambler 1984). The material assemblages at these sites show affinities with Archaic complexes from the eastern Great Basin (Lindsay et al. 1968:121) and the northern Colorado Plateau (Jennings 1980). Several other caves have contributed significantly to our general understanding of the Archaic period within the northern Colorado Plateau, including O'Malley Shelter (Fowler et al. 1973), Sudden Shelter (Jennings et al. 1980), and Cowboy Cave (Jennings 1980).

The well-dated strata and relative abundance of projectile points at the latter two sites allowed Holmer (1978) to delimit distinct shifts in Archaic point types through time. Based on the temporal clustering of point types, Holmer (1978:78) divided the Archaic period into early (ca. 6350-4200 B.C.), middle (ca. 4200-2600 B.C.) and late (ca. 2600 B.C.-A.D. 450) temporal divisions (Figure 31). This tripartite temporal division is useful for discussing the Archaic occupation of the Arizona Strip, with two revisions: 1) a slightly earlier starting date of about 7000 B.C. for the early Archaic, as evidenced by the Dust Devil Cave sequence (Ambler 1984) and 2) a termination of the late Archaic at roughly 300 B.C. following the introduction of domesticates on the southern Colorado Plateau (Smiley et al. 1986; cf. Berry 1982).

Archaic occupation on the Arizona Strip is evidenced by the presence of diagnostic projectile points occurring as isolated artifacts or in association with lithic scatters. Dating of these points to the Archaic period must rely on dates derived from various localities outside the Arizona Strip, since only three Archaic age sites with projectile points have been radiocarbon dated within the boundaries of the project area (Jones 1986b; Wilde 1986). The dating of projectile points is controversial and will undoubtedly be subject to future revisions. Until more stratified cave deposits are excavated on or immediately adjacent to the Arizona Strip, Holmer's (1978, 1986) dates for projectile points from the northern Colorado Plateau provide the best approximation for this area (Figure 32).

Early Archaic Period, 7000 to 4250 B.C.

The earliest Archaic use of the Strip may have occurred some time between 6000 and 4000 B.C., as evidenced by Pinto points recovered from the Navajo-McCullough transmission line survey and excavations (Moffitt et al. 1978:Figure 55a-b), from the Paria Plateau (Mueller et al. 1968), from surveys on the Shivwits and Kanab Plateaus (Teague and McClellan 1978; Euler, personal communication, 1986), and from various localities in Grand Canyon (Euler 1984). In addition, a Northern Side-notched point (Figure 33) was recovered during the Navajo-McCullough transmission line project, although its early Archaic affiliation was not recognized (Moffitt et al. 1978:Figure 54a).

The temporal placement of Pinto points within the Western Archaic tradition has been a subject of continuing debate among archaeologists. The opposing sides in this debate include those who view the Pinto point as a diagnostic of the early Archaic period (Holmer 1978; Schroedl 1977) and those who considered it to be a middle or late Archaic type (Irwin-Williams 1967; Euler and Olson 1965; Euler 1984). Recently, the evidence for the temporal placement of the Pinto point was reviewed by Holmer (1986:97 99). Following Thomas (1981), he noted that part of the confusion may have arisen because of a general morphological resemblance between the earlier Pinto type and a late Archaic point type called Gatecliff Split-stem (Thomas 1981:37-38). Both types have bifurcated stems, but the Pinto point stems tend to be expanding, with shallower basal notches and bulbous tangs, whereas the Gatecliff points usually have a parallel-sided stem with a deep basal notch and pointed tangs (Holmer 1986:97). In addition, Pinto points commonly exhibit basal grinding, whereas Gatecliff Split stem points do not.

An example of this problem is illustrated by Tuohy's (1980:51) claim of concrete evidence for the late Archaic dating of Pinto points. An uncorrected radiocarbon date of 3830 ± 110 B.P. (1800 ± 100

Calender Years	Temporal Periods	Temporally Sensitive Archaic Projectile Point Types	Schroedl's Phases
1000	Formative		
AD/BC	Preformative		Dirty Devil
1000	late Archaic	Gypsum Points, San Rafael Side-notched, McKean Lanceolate	Green River
2000			
3000	middle Archaic	Rocker, Sudden, and Hawken Side-notched	Castle Valley
4000			
5000	early Archaic	Pinto Points, Humboldt Series Points, Northern Side-notched	Black Knoll
6000			
7000			

Figure 31. Temporal Frameworks of the Archaic Period.

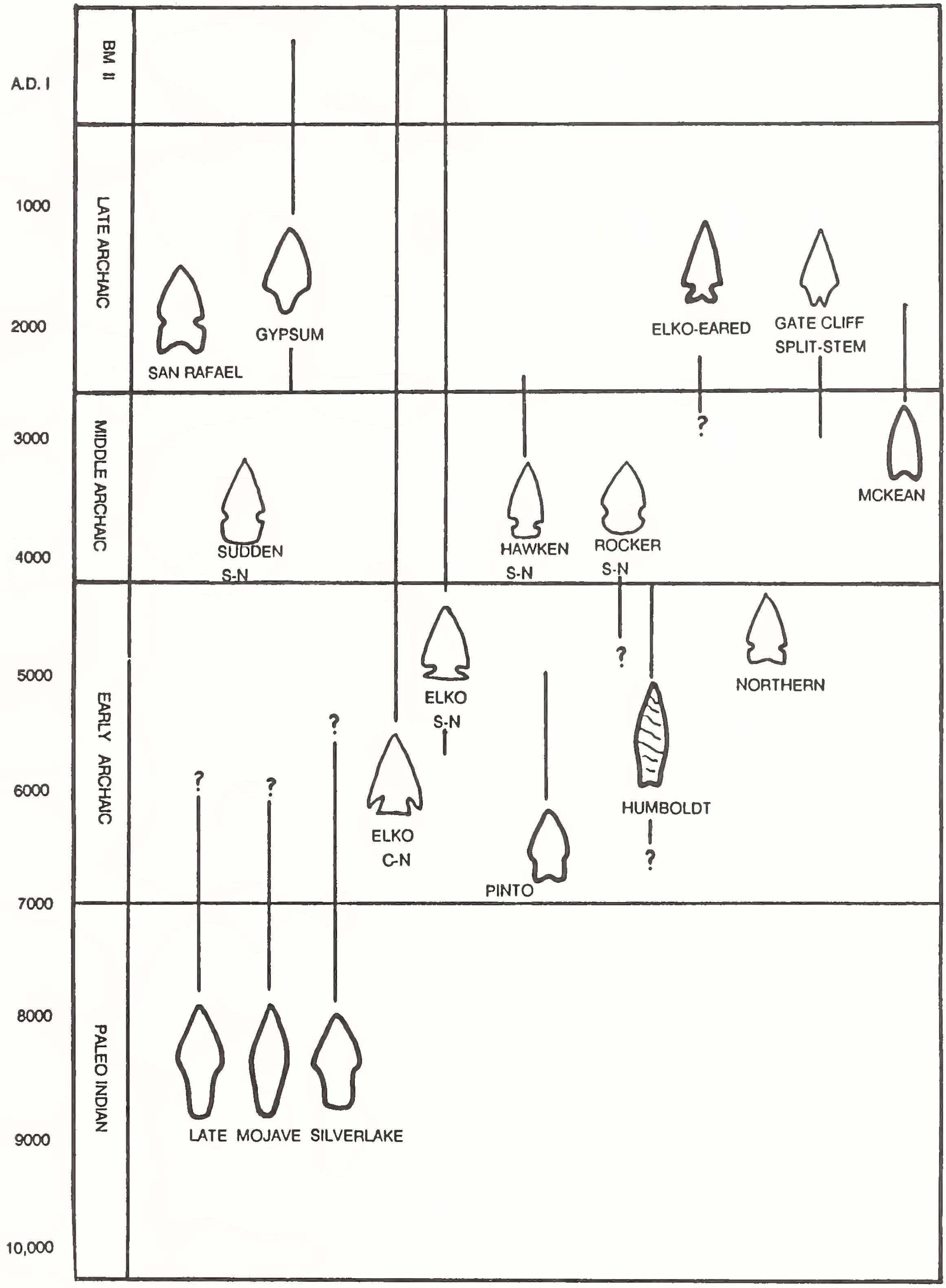


Figure 32. Temporal Placement of Projectile Points (after Holmer 1978).

B.C.) was obtained from a foreshaft with a hafted point that Tuohy classified as Pinto. The morphology of this point reveals it to be a Gatecliff Split stem (Thomas 1981:33).

Although normative attributes generally set Pinto and Gatecliff Split-stem points apart, some morphological overlap is evident. Even though the two point types are not always distinguishable on morphological grounds, the geographical temporal distinction between Gatecliff Split-stem and Pinto holds up well. Bifurcated stemmed points from the northern Colorado Plateau and eastern Great Basin consistently date to the early Archaic period, while those recovered from chronologically controlled contexts in the western Great Basin region are generally confined to the late Archaic period (Holmer 1986). In the Mohave Desert region, however, both "true" Pinto and Gatecliff Split-stem points occur. In this area, geomorphological evidence supports the assignment of Pinto points to the period immediately following the Paleoindian occupation of the Pleistocene Lake Mohave shoreline (Warren 1980:67).

Another point type that may be diagnostic of the early Archaic period is the Humboldt Concave base point. As with the Pinto type, there is still a great deal of inconsistency in the application of this type name, and the dating is similarly confused. Holmer has advocated that the name Humboldt be confined to large lancolate points exhibiting parallel oblique flaking patterns, and has proposed to designate the smaller lancolate forms with unpatterned flaking that commonly occur during the late Archaic period as McKean Lanceolate.

Other point types assigned to the early Archaic include Northern Side-notched, Lake Mohave Silver Lake, and Elko Corner-notched types. On the northern Colorado Plateau, Northern Side-notched points date between 6900 and 6300 B.P. (Holmer 1978:67). As mentioned earlier, the Lake Mohave Silver Lake points are poorly dated but seem to start as early as 9000 B.C. and persist through the first part of the early Archaic period. The Elko Corner-notched points appear during the early Archaic and continue to be used throughout the Archaic and Formative periods.

Aside from the points, the only other potential diagnostics for the early Archaic period are sandals. Open-twined and warp-faced varieties have been found in the early Archaic strata of Sand Dune, Dust Devil, and Cowboy caves (Ambler 1984; Hewitt 1980; Lindsay et al. 1968). Although open-twined sandals were also recovered from the late Archaic level (Unit IV) of Cowboy Cave (Hewitt 1980), Ambler (1984) doubts that the open-twined style continued into the late Archaic. This issue could be resolved through direct dating of Cowboy Cave Unit IV specimens. Certainly, all of the specimens that have been directly dated so far, including one recently recovered from a testing project in the central Glen Canyon area, were manufactured in the early Archaic period (Agenbroad et al. 1987; Ambler 1984; Lindsay et al. 1968).

Middle Archaic Period, 4250 to 2650 B.C.

The characteristic point types of this period include Sudden Side-notched, Hawken Side-notched, and Rocker-Side notched, all of which were originally identified and described from Sudden Shelter (Holmer 1978; Jennings et al. 1980). Recent excavations at Rock Canyon Shelter and Antelope Cave produced Rocker Side- notched points in association with late Archaic types (Jim Wilde, personal communication 1988), indicating that this type may have a longer use span on the Arizona Strip. McKean and Lanceolate types appear during the middle Archaic period and continue into the late Archaic period. Elko Corner- and Side-notched points are also common during the middle Archaic period, but as noted previously are not restricted to this temporal interval and thus cannot be considered as temporally diagnostic.

Evidence for middle Archaic occupation of the Arizona Strip is sparse, as it is for most of the Colorado Plateau and Great Basin region (Berry and Berry 1986). One possible middle Archaic point,

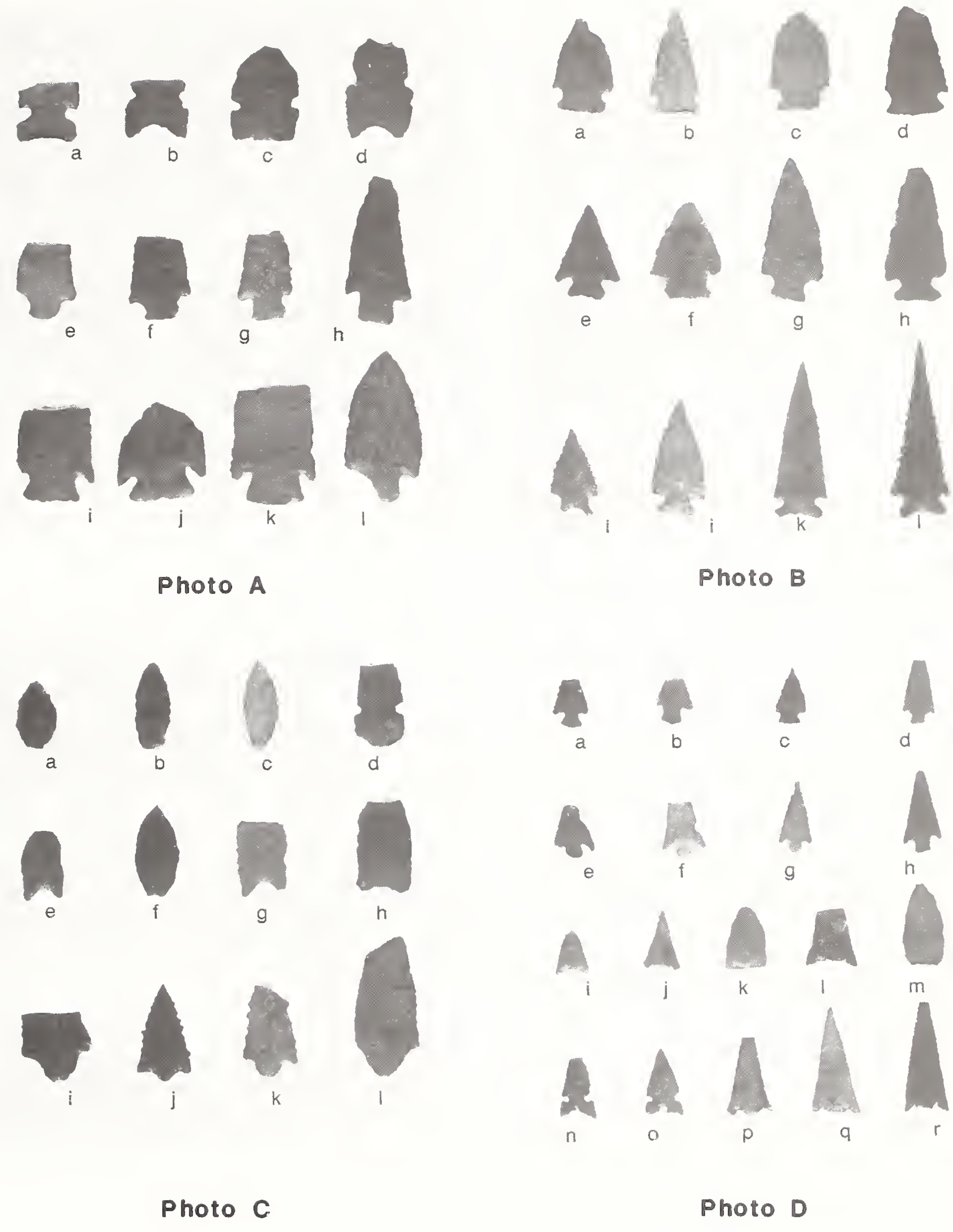


Figure 33. Reclassification of Projectile Points Collected During the Navajo-McCullough Transmission Line Projects. Classification based on Holmer (1978), Holmer and Weder (1980), and Tipps (1984). Photo A: (a) Northern Side-notched, (b,d) San Rafael Side-notched, (c) Sudden Side-notched, (e-h) San Rafael Stemmed, (i-l) Elko Corner-notched. Photo B: (a-h) Elko Side-notched and Elko Corner-notched, (i-l) Elko Eared. Photo C: (a-c) Lanceolate, (d) Rocker Side-notched, (e-h) McKean Lanceolate, (i-l) Gypsum. Photo D: (a-h) Rose Springs Corner-notched, (i-k, m) Cottonwood Triangular, (l) Bull Creek, (n,o) Desert Side-notched, (p-r) Parowan Basal-notched. Photos courtesy of the Museum of Northern Arizona.

a Rocker Side-notched, was found on the central Kaibab Plateau during the Highway 67 survey (Fairley et al. 1984), and a Sudden Side notched-point (not identified as such) is illustrated in the Navajo-McCullough report (Moffitt et al. 1978:113, Figure 54c). Climatic factors have been hypothesized to explain the paucity of middle Archaic remains throughout the Southwest and Great Basin. Although Antevs' (1962) tripartite (Anathermal, Altithermal, Medithermal) Holocene climatic model for the Great Basin is now thought to be overly simplistic, a widespread xeric interval between ca. 5000 and 3000 B.C., roughly corresponding to Antev's Altithermal period, is accepted by many experts (Benedict 1975, 1979; Wendlund and Bryson 1974; Mehringer 1967).

Relying on distributional evidence, which showed middle Archaic remains to be relatively abundant in cool, moist, high elevation areas such as the mountainous regions of southwestern Colorado, Benedict and Olson (1973, 1978; Benedict 1979, 1981) hypothesized that high elevation areas served as refugia from the hot, dry conditions of the middle Archaic period. Sudden Shelter, at an elevation of over 7000 ft, clearly fits this model. If this hypothesis is applicable to the Arizona Strip region, middle Archaic sites are most likely to be found in the highland areas of the Strip, such as the Kaibab Plateau and the Uinkaret and Virgin Mountains. As yet, projectile point data from the Arizona Strip are too spotty to support or refute this hypothesis.

In the central Glen Canyon region, recent radiocarbon dating of a buried cultural stratum at an open dune site produced a date of 5300 ± 235 B.P. (Agenbroad et al. 1986). The position of this site at an elevation of 4,500 ft is clearly not consistent with the pattern noted above. It may be that site specific conditions, in this case the confluence of two perennial streams, need to be considered as well. Alternatively, Geib et al. (1986) suggest that well watered areas in general, rather than strictly high elevation situations, may have been favored during the middle Archaic period. If this is true, then the Virgin River drainage and perhaps the Colorado River and its perennial tributaries would be the most likely areas to produce evidence of a middle Archaic occupation on the Arizona Strip.

Late Archaic Period, 2600 to 300 B.C.

Evidence for a late Archaic occupation on the Arizona Strip is relatively abundant compared to any of the preceding periods. The evidence includes radiocarbon determinations from stratified shelter deposits and split twig figurines, as well as cross dated projectile point types.

Key projectile point types for this period include McKean/Lanceolate, San Rafael, Elko eared, and Gypsum (Holmer 1978). The McKean point was first identified at Sudden Shelter. This concave base lanceolate point bears a general morphological resemblance to the Humboldt Concave type, but it is smaller and does not exhibit the parallel oblique flake scar pattern, which is the hallmark of the earlier type (Holmer 1980, 1986). Most of the points identified as Humboldt Concave in the Navajo-McCullough Transmission line report (Moffitt et al. 1978) are actually McKean. Points similar to McKean but lacking the concave base are simply designated as lanceolate (Amsden 1935; see also Holmer 1980). Lanceolate points have been recovered from the Kaibab Plateau (Fairley et al. 1984:61) as well as from several other localities on the Strip. With respect to temporal placement, evidence from the Sudden Shelter sequence suggests that the distinction between McKean and lanceolate points is of little importance. McKean (initially labeled as Humboldt Concave-base, Variety A2; see footnote in Holmer 1980:76) and lanceolate types overlap in time: 3950 to 1800 B.C. for the former and 2750 to 1750 B.C. for the latter.

Elko Eared points have been recovered from numerous sites in and adjacent to the Arizona Strip (Fairley et al. 1984; Moffitt et al. 1978; Teague and McCllellan 1978). The Elko Eared style has a defined temporal range of roughly 7800 to 1250 B.C. based on dates from Danger, Hogup, and Cowboy caves (Holmer 1978). If only the Cowboy Cave data are considered, the time range for Elko Eared on the Arizona Strip would be roughly 1740 to 1300 B.C. These dates are based on the extreme range of dates from Unit IV (Jennings 1980:19, Table 2), from which the two provenienced Elko Eared points were recovered. Although this temporal range may be too narrow, it is probably a better estimate than the entire 6,550-year range proposed by Holmer (1978).

With its high side notches and deeply concave base, the San Rafael point is not readily mistaken for any other point type. San Rafael is a relatively new type designation not yet extensively used in the literature. Points clearly representing this type have been recovered from the Arizona Strip, as evidenced by two of the "Class 1" points illustrated in Moffitt et al. (1978:113, Figure 54b,d; see also Figure 33, this volume). San Rafael points have also been recorded on the Kaibab Plateau (Fairley et al. 1984; USFS site files), as well as from stratified contexts in Rock Canyon Shelter and Antelope Cave (Jim Wilde, personal communication 1988). Holmer's dates for this type are based on the Sudden Shelter excavations, where eight San Rafael points were found in Strata 15 and 16. He assigns a time range of approximately 2650 B.C. to 1750 B.C. for this type (1978:69). Radiocarbon dates ranging between 3290$\pm$60 to 3590$\pm$50 (1280-1690 B.C.) from Rock Canyon Shelter and the lowermost levels of Antelope Cave (Jim Wilde, personal communication 1988) suggest that this type may have a slightly longer time span on the Arizona Strip. Nevertheless, these dates do support the late Archaic temporal placement of this distinctive point.

The dating of Gypsum points to the late Archaic period on the Colorado Plateau is well established (Schroedl 1977; Holmer 1978, 1986; Berry and Berry 1986). Holmer (1978:70) places the beginning date for this type at 2560 B.C. and an ending date at A.D. 450. Alternatively, Berry and Berry (1986:317) argue for an ending date no later than 1000 B.C. Sites NA 11,500 and NA 11,634 in the Beaver Dam Mountains of southwestern Utah contained preceramic roasting pits associated with Gypsum and other later Archaic point types. Radiocarbon dates from these features ranged from A.D. 190 to A.D. 280 (Moffitt et al. 1978:32, 43). These sites had multicomponent occupations, however, and the associations between features and occupational units were not clear cut. West of the Arizona Strip along the Navajo-McCullough transmission line corridor in southeastern Nevada, Brooks and Larson (1975) reported a date of A.D. 450 from a single component campsite with Gypsum points. This evidence suggests that Gypsum points continued to be manufactured, or at least were in common use, during the Basketmaker II period. Split twig figurines are another late Archaic diagnostic that occur with considerable frequency in and around the Arizona Strip.

Split twig figurines are known from five sites in the eastern Grand Canyon (Schwartz et al. 1958; Euler and Olson 1965; Euler 1984) as well as from several cave sites in the general vicinity of the Strip (Fowler 1973; Geib and Keller 1987). Euler and Olson (1965) initially posited that the figurines were associated with the Pinto complex (see also Euler 1967a), but it is now generally accepted that they are associated with Gypsum points (Davis et al. 1981; Fowler 1973; Jennings 1980; Schroedl 1977). The widespread distribution of split twig figurines and Gypsum points may be indicative of a common late Archaic cultural tradition stretching from southeastern California to east central Utah and encompassing the Arizona Strip.

In addition to the sites noted above, late Archaic dates have been derived from one other site on the Arizona Strip, a sheltered, stratified midden in the inner Grand Canyon near the mouth of Whitmore Wash. A buried roasting pit feature yielded an uncorrected radiocarbon determination of 2940 $\pm$ 60 B.P.; the 95 percent confidence interval of corrected date was 1365 $\pm$ 905 B.C. (Jones 1986b:106). The deposits surrounding the roasting pit feature contained several "San Pedro" style (i.e, Elko) points, but no temporally sensitive artifacts were recovered in direct association with the feature (Jones 1986b:51).

Summary of Archaic Evidence on the Arizona Strip

The evidence for an Archaic presence on the Arizona Strip consists primarily of projectile points associated with open artifact scatters. These scatters are usually interpreted as temporary camps, food processing stations, tool production or "knapping" sites, and lithic "quarries" (G. Brown 1982a, 1982b; Fairley et al. 1984). Residential base camps are rarely identified in the BLM or USFS site files or in published reports.

Archaic points have been recovered from many Formative period sites in the area. In these mixed contexts, it is difficult to determine whether the points are indicative of a multicomponent occupation or whether the later Anasazi occupants of the area scavenged them from earlier sites. Southern Paiute reuse of existing artifacts is well documented (Fowler and Matley 1978) and some of the lithic sites with Archaic point types could well belong to a much later period. Without corroborative dating, the designation of a site as Archaic based solely on the presence of diagnostic projectile points must be considered tentative.

Although the curation and reuse of projectile points limits the reliability of the cross-dating technique, the frequent occurrence of late Archaic style points made from locally available Kaibab chert (G. Brown 1982a; Fairley et al. 1984; Moffitt et al. 1978; Teague and McClellan 1978) suggests that a substantial Archaic population was present on the Arizona Strip, at least during the latter part of the period. A late Archaic presence is corroborated by the dating of split twig figurines from the eastern Grand Canyon and radiocarbon determinations from three sheltered sites farther west: Rock Canyon Shelter (Wilde 1986), AZ:A:16:1 (ASM) (Jones 1986b), and Antelope Cave (Jim Wilde, personal communication 1988). Evidence of early and middle Archaic use of the project area is relatively sparse and limited to surface finds of diagnostic projectile points.

Models of Archaic Settlement Subsistence Strategies

Schroedl (1976:11) defines the Archaic lifeway on the northern Colorado Plateau as "a stage of migratory hunting and gathering cultures following a seasonal pattern of efficient exploitation of a limited number of selected plant and animal species within a number of different ecozones." Although this is an adequate working definition, several of its essential points are subject to testing and possible revision. Certainly the issue of efficiency can be argued, at least in terms of its energetic measure (Michael Berry, personal communication, 1985). Although theoretical models support the notion of seasonal movement across several environments for the exploitation of relatively few economic species, corroborative data are generally lacking. Even if the seasonality model can be substantiated, the degree to which various Archaic groups were nomadic and focused in their subsistence pursuits remains to be established.

Traditional discussions of Archaic adaptation have relied on ethnographic analogy with historic hunter-gatherers to provide the basic models for interpreting archaeological remains of the Archaic period in a broad cultural ecological context. In the Great Basin region and to a lesser extent on the Colorado Plateau, the historic Numic hunter-gatherer adaptation (Steward 1938; Kelly 1964) has provided the primary model for this purpose (Jennings 1957, 1974; Thomas 1973). At a general level, this adaptive strategy is characterized by the intensive exploitation of diverse resources in an established pattern of seasonal transhumance. The uncritical acceptance of the Numic model has tended to obscure consideration of the other options that may have been available to prehistoric hunter-gatherers in the region.

In the past ten years, there has been a tremendous growth in the theoretical literature pertaining to hunter-gatherer adaptations (Bailey 1983; Bettinger and Baumhoff 1982; Binford 1980, 1982; Jochim 1976, 1981; Price and Brown 1985; Winterhalder and Smith 1981; and others). Although these studies do not necessarily deal with the Archaic period explicitly, they do illustrate the range of settlement-subsistence alternatives that were available to preagricultural populations. They help to emphasize the fact that although the Numic pattern of seasonal transhumance was well suited to the patchy, seasonally available resource base of the Great Basin, it was not necessarily the only adaptive option. Other options, such as a highly mobile, non- territorial foraging strategy focused on the exploitation of a few key resources, may have been favored during periods of lower population density or greater resource availability (Bettinger and Baumhoff 1982).

A recent popular approach in the study of hunter-gatherer adaptations focuses on the relative importance of a few key resources in the Archaic subsistence system. Optimal foraging theorists argue that the seasonal availability of specific, highly nutritious seed resources structured the subsistence strategy of foraging societies. This perspective contrasts with the traditional view of the Great Basin hunter-gatherer as an efficient exploiter of virtually every available food source. As discussed in the Neo-Archaic section, this perception of Numic subsistence may have developed as a result of historic circumstances, which forced the aboriginal populations out of the most productive foraging zones, and may not be an accurate reflection of the aborginal Numic subsistence regime.

Binford (1980) argues that the reliability and diversity of resources in a given environment will influence the type of organizational response required to successfully exploit that environment. He describes a continuum of organized subsistence systems ranging from the "collectors" to "foragers." Foragers move as small mobile bands among a series of resource "patches" in an informal seasonal round. They do not store food but gather it daily as needed. Their settlement system is characterized by a series of temporary camps, which they may or may not reuse on an annual basis. The foraging strategy is typical of environments with uniformly dispersed resources, but it may also occur in situations where resources are highly localized (i.e., deserts with scattered waterholes). Collectors, on the other hand, tend to operate out of established base camps, located in proximity to a locally abundant resource. Special task groups move out from the residential base camps and establish logistical camps in distant areas in order to procure additional critical resources. The collector strategy is typical of environments where resources are restricted in diversity but are seasonally abundant and predictable. This adaptation requires storage facilities to preserve critical resources that maintain the group through periods of seasonal shortage.

Most current conceptions of Archaic settlement subsistence systems on the Colorado Plateau posit an intermediate position in Binford's "forager-collector" continuum. Archaic hunter-gatherers are hypothesized to have moved through a range of environments on an annual seasonal round. Temporary base camps were established in optimal habitats, and logistical camps were positioned in less productive areas to procure specific seasonally available resources, some of which were stored for later consumption. Evidence from the northern Colorado Plateau Glen Canyon region (Hall 1972; Hogan 1980; Tipps 1981; Van Ness 1984) indicates that a relatively limited number of plant and animal species provided the majority of calories and nutrition for humans throughout the Archaic period (Geib et al. 1986). Pollen, phytolith, and macrobotanical studies of 97 feces from the early Archaic level of Dust Devil Cave revealed Sporabolus, Opuntia, Helianthus, Chenopodium, and Allium to be the major dietary constituents (Hevly 1984; Hevly and Reinhard 1984; Van Ness 1984). This site seems to have been used primarily as a winter spring base camp (Hevly 1984), thus the diet probably included a large percentage of stored foods. At Cowboy Cave, some of the same flora, particularly Sporabolus and Helianthus, dominated the seed component of coprolites throughout the Archaic occupation (Hogan

1980), leading Jennings (1980:148) to interpret the cave's primary function as a collecting and processing camp for the seeds of economic plants.

Faunal remains from Archaic feces (Reinhard and Czaplewski 1984) and middens (Lindsay et al. 1968; Stroup 1972; Lucius 1980) reveal that lagomorphs were a regular source of protein in the Archaic diet, while mountain sheep were consumed less frequently. At Cowboy Cave a trend for greater reliance on large game during the late Archaic period was evident. Only further investigations will reveal whether or not this pattern is common throughout the Colorado Plateau during this period.

As the foregoing discussion indicates, we are only beginning to recognize trends in Archaic subsistence and settlement patterns on the northern Colorado Plateau. The extent to which these patterns apply to the Archaic occupation of the Arizona Strip is currently unknown. Clearly, we have a long way to go before we can begin to address the specific issues relating to Archaic adaptation in this area. The foregoing discussion is intended to illustrate the types of research problems that need to be addressed. As an initial step towards developing testable models of Archaic adaptation in this region, survey efforts need to focus on temporal diagnostics and specific site characteristics, such as tool assemblages and features, which will allow researchers to identify the range of activities conducted in specific environmental settings at various time periods throughout the region (see Chapter 6). This approach has already been undertaken to a limited extent (e.g. Bond 1982; G. Brown 1982a; Davis and Westfall 1982; Fairley et al. 1984), but it is only with a concerted effort on the part of BLM and USFS cultural resource personnel, in concert with the larger archaeological community, that our understanding of this important period in prehistory can advance beyond the rudimentary level existing at the present time.

FORMATIVE PERIOD

As herein defined, the Formative period on the Arizona Strip spanned the centuries between ca. 300 B.C. and A.D. 1250. Although the terms Puebloan and Anasazi are commonly used to designate this period in prehistory, we have chosen to apply a more general label. By using the term Formative, we hope to avoid a priori assumptions regarding the cultural affiliations of ceramic bearing sites and to acknowledge the possible presence of non-Anasazi peoples (e.g., ancestral Paiutes) in the western Arizona Strip during the latter portions of this period.

The vast majority of sites recorded on the Arizona Strip are attributed to the Anasazi occupation, based on the presence of their distinctive ceramics and to a lesser degree, architectural forms. In traditional studies of Southwestern archaeology, regional branches of the Anasazi culture are distinguished primarily on the basis of geographic variations in ceramics and architecture, with other material culture characteristics of secondary importance in most classifications (c.f., Aikens 1966). Using these criteria, two Anasazi branches, or variants, are commonly recognized on the Arizona Strip: Kayenta Anasazi and Virgin Anasazi.

As traditionally conceived, the Virgin Anasazi branch centered around the Virgin River drainage in northwestern Arizona, southwestern Utah, and southeastern Nevada. Like the other Anasazi traditions to the east, the Virgin Anasazi lifeway was primarily oriented towards a horticultural subsistence base. This primary orientation is reflected in the occurrence of permanent architecture accompanied by extensive storage facilities, ceramic production, horticultural implements such as hoes and digging sticks, and grinding implements suitable for processing large quantities of grain. Further support for a horticultural subsistence focus is indicated by habitation site concentrations situated in proximity to arable land, as well as by the abundant macrobotanical and palyonological evidence indicating that corn, squash, sunflowers, and other cultigens were grown, stored, and consumed at these sites.

In recent years, there has been considerable discussion among archaeologists concerning the relative importance of hunting and gathering in the Virgin Anasazi economy (e.g, Moffitt et al. 1978; Teague and McClellan 1978; Westfall 1987b) and among the Anasazi in general (e.g., Powell 1983). A generalized subsistence model of a mixed horticultural foraging regime involving a certain degree of seasonal mobility has gained a steady following over the years. Although the hypothesis that wild foods constituted an important component of the Virgin Anasazi diet seems supportable on both empirical and logical grounds, the logistical strategies employed by the Virgin Anasazi in obtaining their sustenance remains open to debate.

In the following discussion, a variety of settlement- subsistence models are proposed to account for the diverse assortment of site types and settlement patterns observed in the Virgin Anasazi region. Some of this apparent diversity may be temporal and some may be a reflection of social factors, but much of it appears to reflect the Virgin Anasazi's adaptive flexibility in the face of an ecologically diverse and climatically unpredictable environment. Despite general similarities with other Anasazi traditions, there are patterned differences in site layouts and architecture, as well as in "ethnic identifiers" such as ceramic vessel forms and stylistic embellishments, which distinguish Anasazi remains of the Arizona Strip from those of the neighboring Kayenta region. Many of these differences are relatively minor; if the differences were major, then there would be grounds for distinguishing a separate cultural entity, rather than a regional variant of the Anasazi tradition. The processes responsible for the development of these regional variations have not been eludicated, but a combination of environmental and social factors, including relative isolation from the main segment of Anasazi population and interaction with non-Anasazi groups to the north, west, and south, may have contributed to the emergence of Virgin Anasazi ethnicity.

In several publications dealing with the archaeology of northwestern Arizona, the Virgin Anasazi are referred to as a sub-branch of the Kayenta (e.g., Heid 1982; Thompson 1971b; Thompson et al. 1983). Although Gladwin and Gladwin (1934) originally depicted a "Nevada" branch splitting off from the Kayenta at the beginning of Pueblo II, this postulated relationship was based on very little data. Colton (1942, 1943) subsequently established a distinct and independent Virgin branch that spanned the entire Anasazi developmental sequence and was equivalent in all respects to the Kayenta, Mesa Verde, and Chacoan branches. Colton objected to Gladwin's original branch name because "the name of a large state is not a satisfactory name for a branch which only covers a small area of a large state" (1952:5). Colton (1943:265-266) was quite explicit about the definition of Anasazi branches in anthropological terms.

> A branch, as I see it, and as I think Gladwin visualized it, is not simply a subdivision of a classification of culture. It includes much more than that, because it is defined by all the surviving attributes of a prehistoric tribe: (1) physical remains of individuals, (2) social organization, (3) religion, and (4) material culture. Material culture, because it is the best preserved and furnishes the greatest number of traits, has mixed up our thinking, causing us to consider that the Gladwin system of Roots, Stems, Branches, and Phases (Foci) is a classification of culture. It is not that, but it is a classification of prehistoric human groups.

Traditional summaries of Southwestern prehistory (e.g., Colton 1943; McGregor 1941) depict the Kayenta Anasazi occupying the region south and east of the Colorado River and north of the Little Colorado River as far east as Chinle Wash. Virgin Anasazi territory is usually defined as the region north and west of the Colorado from Paria Canyon to the Muddy River, and as far north as the Pink Cliffs in Utah. Most archaeologists are in general agreement with these territorial distinctions prior to ca. A.D. 1000 or 1050. The picture becomes more muddled during the Pueblo II period: some scholars argue for an extension of the Virgin Branch territory north of the Colorado River as far east as the Kaiparowits-Escalante area (Hauck 1979c; Gunnerson 1959a; Thompson et al. 1983; Westfall 1986) whereas others maintain that these areas were occupied by Kayenta Anasazi (Lister 1964). Furthermore, several scholars (Effland et al. 1981; Euler 1967a, 1979; Jones 1986a, b) maintain that the Kayentan cultural expression (if not actual populations) encompassed the region north of the Colorado as far west as Kanab Creek during Pueblo II times.

The origins of this debate are rooted in the research efforts of the Glen Canyon project, especially the surveys and excavations conducted on the Kaiparowits Plateau (Gunnerson 1959a; Fowler and Aikens 1963; Aikens 1962) and at the Coombs Site in Boulder, Utah (Lister 1959; Lister et al. 1960; Lister and Lister 1961). Sites on the Kaiparowits Plateau were initially attributed to Virgin Anasazi (Gunnerson 1959a). Concurrent with Gunnerson's work on the Kaiparowits Plateau, the Listers excavated at the Coombs site. Florence Lister had little experience with Kayenta or Virgin Anasazi ceramics prior to undertaking the Coombs investigations, and her lack of familiarity with western Anasazi ceramic traditions is reflected in her classification of the Coombs ceramic collection. She interprets the Coombs ceramic collection as predominantly Kayentan, even though many aspects of the assemblage are more characteristic of the Virgin ceramic tradition. Virgin attributes in the Coombs assemblage include the predominance of plain wares, the dominance of San Juan Red ware over Tsegi Orange ware, as well as certain design styles and vessel forms. The only ceramics Lister identified as Virgin branch were the Shinarump wares (she called them Tusayan Gray ware: Southern Utah Variety, Aikens 1965:93) and those exhibiting fugitive red exteriors (Aikens 1965:99), the latter trait being characteristic of both the Virgin Anasazi and the Parowan Fremont ceramic traditions.

Florence Lister had considerable influence over the analysis of the Kaiparowits excavation collections (J. Richard Ambler, personal communication 1987), which accounts, at least in part, for the reinterpretation of the Kaiparowits occupation as Kayentan (Fowler and Aikens 1963:4; Lister 1964:75). A subsequent study of cultural interactions in the Glen Canyon region based on ceramic ware distributions (Lister 1964) added fuel to the debate concerning the extent of Kayenta Anasazi occupation in the Glen Canyon region. Lister (1964:66) questioned the validity of the Virgin branch as an archaeological entity.

> Out of this restudy one firm thought has come: Kayenta pottery should be unshackled from the "Virgin branch" and "Johnson branch" notions: these are branches, it must be pointed out, that were defined ceramically and have no meaning in other aspects of the culture. It is now anticipated that work in southern Utah will allow us to suggest that both terms be discarded, that in their place the Kayenta branch ought to be regarded as including an unspecialized southern Utah sub branch differing in pottery and all other traits only in minor details.

The question over the distinction between Virgin and Kayenta manifestations in Glen Canyon prompted the University of Utah to undertake excavations in the heart of the Virgin territory in order to compile a body of comparative excavation data specific to that area (Aikens 1965). Shortly thereafter, Aikens (1966) undertook his landmark study of Virgin Kayenta cultural relationships in which he sought to compare the two traditions using criteria other than ceramics. His study included comparisons of domestic and ceremonial architecture, site layouts, subsistence, technology, dress, and ornamentation. Although a number of differences were noted between the two areas during various time periods, particularly during the "Late Florescent period" (Pueblo II), Aikens decided that these differences were relatively inconsequential in comparison to the overall similarities. He concluded that the Virgin and Kayenta traditions evolved out of a common elementary Southwestern (Basketmaker II-III) base, which had newly extended itself over the whole of the northern Southwest (Aikens 1966:55). During this time period, the Virgin and Kayenta Anasazi participated "in a uniform cultural pattern and sociological interaction sphere" (Aikens 1966:55). Aikens postulated that increasing differentiation of formal cultural features, particularly in terms of site layouts, religious architecture, and ceramic traditions during the Pueblo I period culminated in the formation of discrete sociocultural populations in the Virgin and Kayenta regions by approximately A.D. 900. The processes responsible for this regional differentiation were not discussed. He observed, however, that this was a widespread phenomenon across the northern Southwest between ca. A.D. 900 and 1100. He also noted that a considerable amount of interaction continued between the two areas during the following period, as evidenced by the frequent occurrence of Kayenta trade wares on Pueblo II Virgin Anasazi sites.

Aikens has often been interpreted as supporting the idea that the Virgin Anasazi were offshoots of the Kayenta Anasazi, and that they essentially were part of the same tradition (i.e., they were both Kayentan). This is a misinterpretation of Aikens' views. Aikens' thesis is that the two traditions developed independently from the same cultural roots and diverged through time to become separate sociocultural populations (Aikens 1966:53). In fact, Aikens explicitly divorced himself from the alternate position as the following quote clearly demonstrates.

> Continuing cultural interchange is demonstrated by trade ceramics; interestingly, most of the influence appears to have been one way, from Kayenta to Virgin, though this may be due, at least in part, to the bias of archaeologists, who have for years considered the Virgin an offspring of the Kayenta and hence logically a receiver, rather than a sender, of cultural impulses [Aikens 1966:55].

Although Aikens was somewhat equivocal over the distinction between the Virgin and Kayenta branches, Jennings (1966:55) was not: he sided with Lister and characterized the distinction as spurious. At the same time, he noted that the abandonment of the Virgin branch concept had obvious implications for all the other regional "cultures" of the Anasazi as well. Jennings argued that the essential similarity of all Anasazi branches during the early Formative aligned them more closely than their variant ceramics and architecture set them apart. Apparently, only Virgin and Kayenta archaeologists paid attention to Jennings' arguments. The validity of the Virgin branch has been an ongoing topic of debate ever since. Meanwhile, the validity of the other Anasazi branches goes unchallenged.

At one point, Thompson (Thompson 1978b:68) advocated substitution of the term "Western Anasazi" for Virgin, since it did not carry the same cultural historical baggage as the original term. In recent years, however, "Western Anasazi" has been used to designate all the Anasazi manifestations in northern Arizona, including the Kayenta and Winslow branches (e.g., Plog 1979). Therefore, it seems prudent to retain the term Virgin Anasazi in its original sense to differentiate the Anasazi cultural manifestations west and north of the Colorado River from the similar, but by no means identical, Kayenta branch to the east.

Temporal Subdivisions of the Formative Period

A diverse assortment of temporal schemes has been used to subdivide the Formative period on the Arizona Strip (Figure 34). Harrington (1930b) originally proposed two phases, Lost City and Mesa House, to distinguish Pueblo II and Pueblo III ceramic and settlement patterns in the Moapa Valley. In 1934, Gladwin and Gladwin suggested the names Moapa and Parowan to identify the same two phase divisions. By 1952, when Colton published his first ceramic series volume, the Pecos stages (Pueblo I, Pueblo II, Pueblo III, etc.) were in the process of being redefined as temporal periods. Colton tied Harrington's phase names to specific temporal spans, using the dates most commonly applied to those periods: Pueblo II (Lost City phase) A.D. 900-1100 and early Pueblo III (Mesa House phase) A.D. 1100-1150. Colton advocated the use of Harrington's original terminology over Gladwin's, because Harrington's names had priority. Colton also added a third phase, Muddy River (A.D. 600-900), which he equated with the Basketmaker III-Pueblo I period. Colton's phases were actually nothing more than names for ceramic assemblages, since there was relatively little published information pertaining to other aspects of material culture.

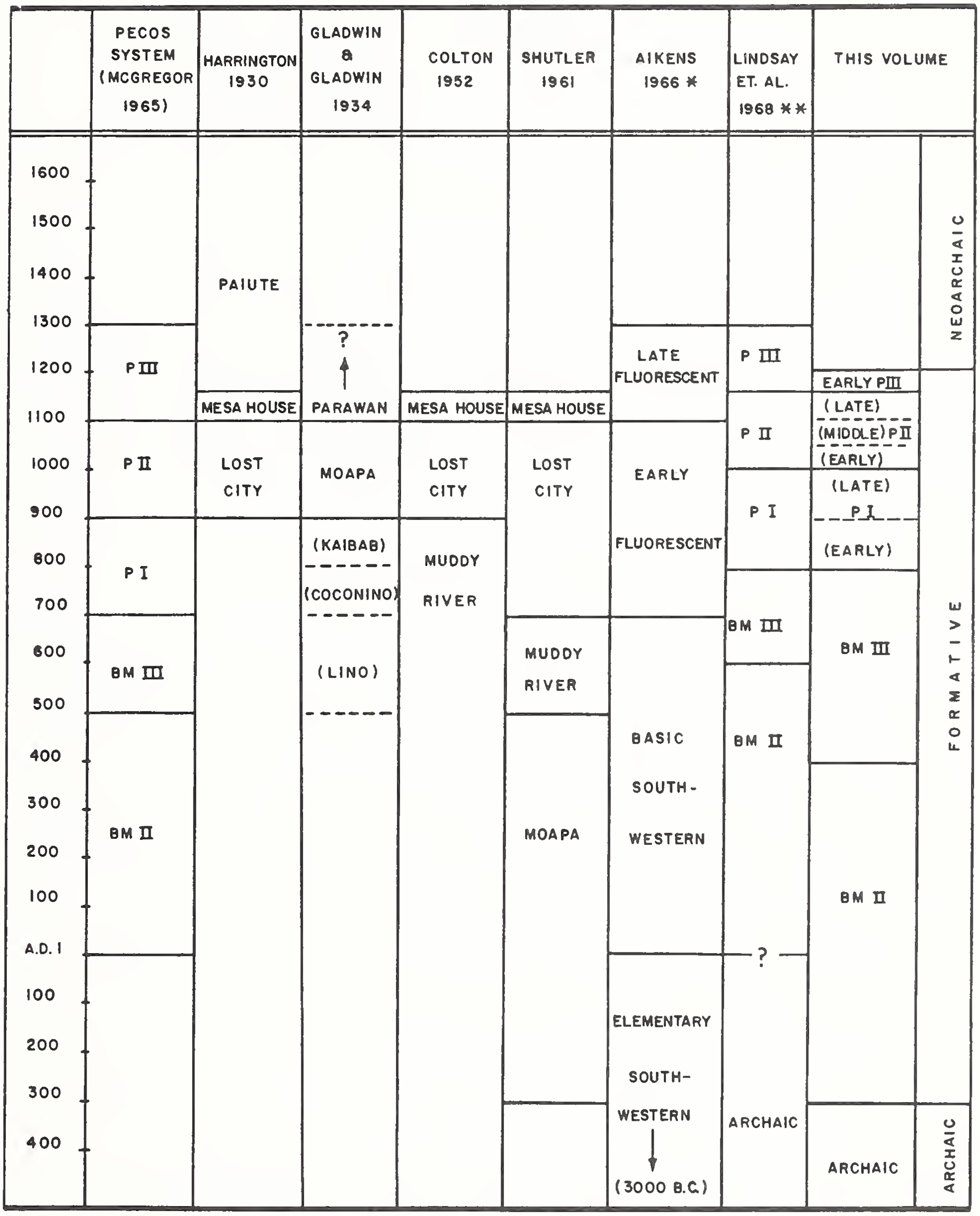
In 1961, Shutler published a revised phase sequence for the Moapa Valley region. He retained Colton's terminology, but revised the temporal spans of the Lost City phase to include the Pueblo I-Pueblo II periods, A.D. 700-1100. Muddy River was restricted to the Basketmaker III period, A.D. 500-700. In addition, he named a fourth phase, Moapa, corresponding to the Basketmaker II period, which he dated from 300 B.C to A.D. 500. For the first time, he attempted to define the cultural correlates of each phase in terms other than purely ceramic ones. The following is a brief summary of Shutler's phase system. The complete version is available in Shutler (1961:67-69).

<u>Moapa Phase (300-500 A.D.)</u>. Dwellings consist of pithouses located on high bluffs above the valley floor. Pithouses range from 2 to 20 ft in diameter and 1.5 to 6 ft in depth. Most pit walls are earthen, but a few are slab-lined. Floors are of plastered adobe with a circular or rectangular clay-lined hearth located off center. Pithouses may have a central roof support post. Storage cists are located in caves. Artifacts include triangular straight-based knives, stemmed or corner-notched dart points, choppers, scrapers, drills, manos, and unclassified stone disks. Perishables are similar to Basketmaker II materials from Cave Dupont. There are no ceramics.

<u>Muddy River Phase (A.D. 500-700)</u>. Clusters of one to four pithouses are located either on high mesa rims or on low knolls within the valley, indicating that people were beginning to farm the valley floor and move closer to their fields. Spatial arrangements of the pithouses show no apparent community structure or pre- planned village layouts. Hunting and gathering continue to be important, as indicated by the presence of Basketmaker III sherds at campsites in the surrounding uplands. Rockshelters and caves continue to be used. The pithouses are round with adobe plastered floors. Interior hearths may be slab-lined, clay-rimmed, or simple unlined basins. Bins and cists, located both in the open and in sheltered areas, are used for storage. Plain gray pottery is manufactured, along with clay pipes and figurines. Small stemmed and notched points are common, indicating use of the bow and arrow. Other lithic artifacts include blades, scrapers, choppers, hammerstones, and chipped or ground disks. Both slab and basin metates were used. In addition, there are bone awls, spatulae, flakers, pendants, and dice, as well as coiled and twined basketry, fur cloth, and cordage. Burials are in the flexed positions and are usually accompanied by pottery or other grave goods.

<u>Lost City Phase (A.D. 700-1100)</u>. This is the period of greatest population density. Sites are located on low knolls within the valley, close to arable land. Corn, beans, squash, and cotton were raised, perhaps with the aid of irrigation. Hunting and gathering continue to supplement the cultivated foods. Villages are composed of both pithouses and surface rooms, arranged in a U or linear fashion, or in clusters of rooms forming blocks. A variety of construction techniques are employed. Ceramic assemblages continue to be dominated by plain wares, but painted and decorated types are also manufactured. Cotton cloth is woven. Lithic and basketry artifacts similar to those of the preceding phase occur, while some artifact types such as Utah and trough metates and stone balls appear for the first time. Salt and turquoise are mined, and extensive trade networks are maintained with the surrounding areas.

<u>Mesa House Phase (A.D. 1100-1150)</u>. Population declined during this period. Sites tend to be situated in defensive positions on ridges high above the valley floor. Site layouts tend to be more enclosed, with rooms ringing a central courtyard. A variety of architectural techniques are used in the construction of pithouses and surface rooms. There is an increase in corrugated over plain wares. The lithics, groundstone, and perishable artifacts of the preceding Lost City phase remain in use throughout this period. Abandonment of the area due to unknown causes occurred about A.D. 1150.



* INCLUDES BOTH VIRGIN AND KAYENTA ANASAZI

** REFERS PRIMARILY TO KAYENTA ANASAZI OF THE GLEN CANYON REGION.

Figure 34. Formative Phase Divisions.

Shutler's phase descriptions were based entirely on Moapa Valley data, and were not necessarily intended to apply to the entire Virgin Anasazi region. Furthermore, he focused almost exclusively on material culture traits to define each phase. Increasing reliance on horticulture through time was implied but not explicitly stated. Archaeologists immediately latched on to this framework because it provided a convenient, ready-made summary of Virgin branch culture history. Through constant repetition it has taken on a life of its own, despite the mounting evidence against the validity of such a simplistic evolutionary sequence of cultural development. There is increasing evidence to suggest that Shutler's phase descriptions may not prove to be an entirely accurate synopsis of Anasazi developments even within the Moapa River Valley, and the applicability of his phase definitions for the rest of the Virgin Anasazi region is certainly open to question.

One other phase sequence devised for a specific portion of the Arizona Strip should be mentioned here. The surveys and excavations conducted by the School of American Research at Unkar Delta revealed several temporally distinct ceramic assemblages, which Schwartz et al. (1980:8) interpreted as evidence of a discontinuous occupational sequence spanning a 250-year period from A.D 900 to 1150. For convenience in organizing and analyzing the Unkar Delta data, he assigned labels to these occupational intervals: Medicine Valley (ca. A.D. 900), Vishnu (A.D. 1050-1070), Zoroaster (A.D. 1075-1100), and Dox (A.D. 1100- 1150). Each of these phases was said to be characterized by distinct shifts in site location and architectural plans, as well as in ceramics. Schwartz argued that each phase represented discrete periods of settlement and abandonment brought about by climatic changes. Schwartz's phase system has been roundly criticized for creating an artificial sense of discontinuity in the archaeological record to support his model of climatically induced settlement shifts (Janet R. Balsom, personal communication 1984). Certainly the five-year occupational hiatus between the Vishnu and Zoraster phase could not be recognized on the basis of ceramic assemblages alone, and it is doubtful that any other dating technique could detect such a short break in the occupational sequence. Perhaps because of these criticisms and the fact that the phase divisions were based on data from a single, geographically restricted locality, Schwartz's phase system has not gained widespread credence as a scheme for organizing the occupational history of the eastern Grand Canyon in general.

Phase sequences can be useful tools for organizing spatial and temporal data on a local level. Problems inevitably arise, however, when one attempts to apply the scheme to a broad region, since cultural patterns do not necessarily occur synchronically over an entire region. Because of the cultural evolutionary baggage accompanying Shutler's phase sequence, I advocate the use of nonlocalized Pecos period designations to organize the data from the Arizona Strip into a temporal framework. Substitution of the Pecos classification system for Shutler's phase sequence is desirable for several reasons. Although the primary intention of the original Pecos Classification was to distinguish stages of Anasazi cultural development, this function has diminished in importance over the years. Instead, the Pecos system is now widely regarded as a convenient temporal (as opposed to developmental) framework, which does not necessarily imply a gradual evolutionary sequence. In this capacity, the role of ceramics as temporal diagnostics supercedes other cultural traits in importance for distinguishing each period. Although there are some apparent trends in terms of architecture, site layouts, economic orientation, and regional settlement patterns through time, the idea that each period is characterized by an amalgamation of specific cultural characteristics that changed in tandem from one period to the next is simply untenable. For example, consider the temporal distribution of large C shaped pueblos. Although once thought to be diagnostic of the Mesa House phase, this architectural form is known to occur as early as Pueblo I times (e.g. Jenkins 1981; Dalley and McFadden 1985). In this overview, Puebloan periods are used as divisions of the Formative period. Archaeologists working in the Virgin Anasazi region have traditionally employed standardized 200 year long temporal divisions when discussing sites in relation to the Pecos period system. According to this scheme, Basketmaker III spans the two centuries between A.D. 500 and 700, Pueblo I lasts from A.D. 700 to 900, Pueblo II continues from A.D. 900 to 1100, and Pueblo III is represented by a 50-year interval, followed by a general abandonment at A.D. 1150.

A number of revisions to this traditional Virgin Anasazi temporal framework are proposed here, based partly on chronometric information currently available from the Virgin Anasazi region and partly on the temporal scheme already established for the Glen Canyon region (Jennings 1966; Lindsay et al. 1968). Application of the Glen Canyon temporal framework to the Arizona Strip is appropriate for several reasons: 1) the Glen Canyon temporal scheme is based on estimated time spans of several widely occurring ceramic types; 2) the temporal spans assigned to these diagnostic ceramic types are supported by dendrochronological dates; 3) northern Kayenta ceramic analogs and trade wares provide the primary temporal diagnostics of the Formative period on the Strip; and 4) the Glen Canyon region is adjacent to the Arizona Strip, and interaction between these two areas appears to have occurred on a regular basis throughout most of the Formative period. For reasons discussed below, Shutler's beginning date for the Basketmaker II period is retained without modification, but an earlier ending date of ca. A.D. 400 is proposed. The Basketmaker III period is expanded somewhat to include the four centuries between A.D. 400 and 800; the later ending date appears to be consistent with current radiometric dating of Basketmaker III and Pueblo I ceramic assemblages in the Virgin Anasazi region (Walling et al. 1986:355,448). Pueblo I spans the period between A.D. 800 and 1000, followed by Pueblo II at A.D. 1000 to 1150. The interval between ca. A.D. 900/950 to 1050, which some Virgin Anasazi archaeologists refer to as "early Pueblo II," is considered here to be late Pueblo I to early Pueblo II; this is followed by mid and late Pueblo II at A.D. 1050-1100 and 1100-1150 respectively. The Pueblo III period (A.D. 1150-1300) appears to be poorly represented on the Arizona Strip and in the Virgin Anasazi area generally, but at least a few sites dating to the late 1100s are known to exist in eastern Grand Canyon (Jones 1986b) and on the Paria Plateau (Mueller et al. 1968), and two sites on the Kanab Plateau have produced dates in the early to mid-1200s. Thus, A.D. 1225 is suggested as the terminal date for Pueblo III on the Arizona Strip.

One final note on semantic distinctions is required here. Technically, the Pecos system only applies to the Anasazi tradition. Since the Anasazi dominated the Arizona Strip throughout the Formative, the use of the Pecos system for organizing the discussion of Formative culture history is appropriate. In using the Pecos system, however, it is essential that we do not allow the terminology to dictate our perspective and thereby exclude consideration of the possiblility that non- Anasazi groups also made use of the Arizona Strip during the Formative. In the following discussion, the Pecos period classifications are divested of cultural implications and are used only to designate specific intervals of time.

Basketmaker II Period, ca. 300 B.C.-A.D. 400

The concept of Basketmaker II has often been used to refer to an assemblage of cultural materials distinct from earlier Archaic remains and distinct from contemporaneous remains found to the west and north of the Arizona Strip (Berry and Berry 1976; Geib et al. 1986). For example, Matson (n.d.) uses the term Basketmaker II in a very specific sense to designate a distinctive cultural assemblage and mixed horticultural foraging adaptation that was directly antecedent to the Puebloan Anasazi culture. In this overview, however, Basketmaker II is used in a more generic sense to designate the period between ca. 300 B.C. and A.D. 400. This restricted use of the term acknowledges the possibility that contemporaneous non-Anasazi populations may have occupied portions of the Arizona Strip during this time span.

In the Virgin Anasazi area, the phase name Moapa (Shutler 1961:64) has commonly been used to designate the period when horticulture was first practiced on the Colorado Plateaus, but prior to the development of pottery and sedentary villages. Shutler dated this phase from 300 B.C. to A.D. 500. Shutler's beginning date was based on the 250 B.C. radiocarbon date from a preceramic level at Willow

Beach, which Schroeder designated Basketmaker II based on point typology. The terminal A.D. 500 date reflected Colton's estimated dates for the beginning of pottery production on the Colorado Plateau; this must now be revised somewhat in light of more recent chronometric data from ceramic bearing sites on the Arizona Strip and adjoining areas of southern Utah (see discussion of Basketmaker III).

Although our beginning date for Basketmaker II is equivalent to the beginning date for the Moapa phase, the reasoning behind it is entirely different. No evidence of cultigens was recovered from the preceramic level at Willow Beach, which Schroeder ascribed to Basketmaker II, yet the initiation of the Formative period, and by extension Basketmaker II, is dependent on dating the introduction of domesticates. Berry's (1982:15-33) thorough analysis of the problem reveals that the earliest directly dated maize on the northern Colorado Plateau, from Cowboy Cave, dates just after 200 B.C. Berry originally argued that this date represented the earliest presence of corn on the entire Colorado Plateaus, but recent radiocarbon dating of cultigens from several classic Basketmaker II sites in the Marsh Pass-Black Mesa region of northeastern Arizona (Kidder and Guernsey 1919; Guernsey and Kidder 1921) indicates that corn was present there by 560 B.C. (Smiley et al. 1986). Currently, the earliest dated corn from the Arizona Strip falls just prior to A.D. 1 (James Wilde, personal communication 1988). Since this date is likely to be superceded by earlier determinations in the future, a conservative estimate of 300 B.C. seems appropriate. Needless to say, future direct dating of Basketmaker II perishable artifacts and cultigens from the Arizona Strip may require reassessment of this proposed beginning date.

During the Basketmaker II period, a more-or-less uniform preceramic horticultural culture apparently extended from southwestern Colorado, across northern Arizona and southern Utah, at least as far west as the central Arizona Strip. Regional variants of this ancestral Anasazi culture are not readily definable at this early time period. The uniformity of the Anasazi culture during its initial stages of development may be a function of a highly mobile settlement-subsistence strategy, which encouraged interaction across a broad region. Alternatively, low population density during Basketmaker II may have forced individuals of marriagable age to seek spouses in distant areas, thereby promoting the spread of a uniform cultural tradition over a wide area (Wiessner 1977; Wobst 1974).

In addition to corn and squash, the Anasazi culture during the Basketmaker II period is known for its extensive array of sandals, coiled baskets, rabbit fur blankets, human hair cordage, fiber and hide bags, dart foreshafts, atlatls, snares, nets, and other paraphenalia common to hunter-gatherers. The specific manufacturing techniques employed in the production of many of these items is distinct from those of preceding Archaic cultures on the Colorado Plateaus (Adovasio 1980; Jennings 1980; Matson n.d.). The apparent lack of antecedents for the classic Basketmaker II assemblage on the Colorado Plateau led Morris and Burgh (1954) and others more recently (Berry 1982; Geib et al. 1985; Matson n.d.) to argue for an intrusion of Anasazi horticulturalists onto the Colorado Plateaus at the start of this period, rather than an in situ development out of a pre-existing late Archaic population. This view contrasts with an alternative model of evolutionary progression out of an Archaic hunting-gathering subsistence system to one incorporating horticulture as an additional component of the hunting-foraging subsistence cycle (e.g., Irwin-Williams 1973).

Although Anasazi peoples clearly were present in the eastern portion of the Strip during this period (Janetski and Hall 1983; Judd 1926; Nusbaum 1922), it has not yet been conclusively determined whether the contemporaneous occupation in the western Strip (Harrington 1937c; Schroeder 1953, 1961; Shutler 1961:5-6) and western Grand Canyon (Jones 1986b) is an extension of the Basketmaker II Anasazi culture or part of another, unrelated tradition. Euler (1962:115) and R.G. Matson (personal communication 1987) question Schroeder's designation of the preceramic level at Willow Beach as a western variant of the Basketmaker II Anasazi culture. Euler suggests that it may be an expression of the contemporary Amargosa II tradition defined by Rogers (1945). The main obstacle to resolving this issue is that, in the absence of perishable artifacts and cultigens, Basketmaker II remains are not readily separated from those of other preceramic cultural groups. Given this fact, the assignment of aceramic pithouse sites along the lower Muddy River to the Basketmaker II Anasazi on the basis of a lack of ceramics and the presence of stemmed and corner-notched dart-size points (Harrington 1937; Schroeder 1953a,1953b; and Shutler 1961) is clearly in need of re-evaluation.

Diagnostic Basketmaker II Artifacts. In terms of specific distinguishing characteristics of Basketmaker II Anasazi material culture, two forms of sandal construction are most common: four-warp wickerwork and multi-warp cord with square, fringed toes. Twined apocynum bags decorated with red and black designs and S-curved "rabbit sticks" are other characteristic Basketmaker II Anasazi traits. Typical coiled baskets have two-rod and bundle foundations with non-interlocking stitches. This technique continues into the Pueblo III period (Lindsay et al. 1968:99; Adovasio and Gunn 1986), and thus is not diagnostic of the Basketmaker II time period per se. Nevertheless, since this basketry technique is not characteristic of Great Basin Archaic technologies (Adovasio 1980:39), its occurence on aceramic sites with dart-sized points is a strong indication of Basketmaker II Anasazi.

In the absence of perishable items, the distinction between Archaic and Basketmaker II material culture is difficult to establish. Slab-lined cists, basin milling stones and one-hand cobble manos, Gypsum and Elko-like side- and corner-notched projectile points are often associated with Basketmaker II, as well as with earlier and later hunting and gathering groups. Recent studies by Matson (n.d.) indicate that there may be a number of characteristics distinctive of Basketmaker II lithic tool assemblages. These characteristics include a lack of side and end scrapers; frequent occurrence of large triangular "knives" with square bases; "snapped denticulates"; thin, well-made triangular projectile points with deep side notches or open corner-notches parallel to the blade edge; and less well-made points with shallow, open side-notches (Matson n.d.). As yet, no one has applied a formal analytical approach, such as those developed by Ritter and Matson (1972) and Holmer (1978), to test whether perceived morphological distinctions in projectile points are valid criteria for distinguishing Basketmaker II types from similar styled Elko points.

Basketmaker II Site Distributions. Evidence for a Basketmaker II Anasazi occupation on the Arizona Strip is relatively limited. This is probably a reflection of archaeologists' continuing inability to distinguish the remains of this period from terminal Archaic and later aceramic specialized activity sites in survey situations. The best evidence for Basketmaker II Anasazi occupation on the Arizona Strip is found at Antelope Cave (AZ:A:3:1[BLM]) (Janetski and Hall 1983). An atlatl similar to those recovered from Basketmaker II levels at Sand Dune Cave (Lindsay et al. 1968:64) was recently recovered from this site and radiocarbon dated at 1850 ± 60 B.P. (A.D. 40 ± 160) (Joel Janetski, personal communication 1986). Other perishable Basketmaker II items recovered from the cave include a net fragment, human hair cordage, and finely woven multiple-warp square-toed sandals (Janetski and Hall 1983:47; Johnson and Pendergast 1960).

Heaton Cave (AZ:B:5:27[BLM]), northeast of Mount Trumbull, also contained Basketmaker II Anasazi artifacts. Judd (1926:147-148 and Plates 51 and 57a) illustrates diagnostic square-toed multiple-warp sandals and S-curved sticks excavated from the site by Franklin A. Heaton, an early resident of Kanab.

Thompson and others (1983; Thompson and Thompson 1974) reported on the excavation of two pit structures in the Tuweep Valley area that were ascribed to Basketmaker II on the basis of six radiocarbon determinations pre dating A.D.320. Both pit structures were associated with plain gray ceramics. These dates, all from charcoal, may or may not be accurate indicators of pre-A.D. 500 pottery use on the Arizona Strip, but because the presence of plain gray ceramics, by definition, places the structures within the Basketmaker III period, they are discussed below within the context of that period.

Evidence for Basketmaker II Anasazi use of areas immediately adjacent to the Arizona Strip is more abundant, but by no means plentiful. Cave Dupont, the most famous Basketmaker II site in southwestern Utah, contained over 30 slab-lined cists ranging from 1 to 2 meters in diameter, as well as numerous well preserved coiled baskets, snares, sandals, and human remains. The cave contained a large number of corn cobs, presumably representing seed caches. In addition, seeds of sunflower, ephedra, yucca, and chenopodium were also recovered.

In southeastern Nevada, at least six aceramic pithouse sites in the upper and lower Moapa Valley (Harrington 1937c; Schroeder 1953) have been classified as belonging to the Basketmaker II Moapa phase (Shutler 1961:5-6). The pithouses range from three to six m in diameter and up to two m in depth. They are either circular or oval in plan, and lack ventilator shafts, centrally situated firepits, benches, and lateral entries. Most have circular, adobe-lined firepits situated off-center, but some are devoid of floor features. One of these pit structures is described as having a central posthole and a rectangular, clay- lined firepit immediately to the east (Schroeder 1953:65). The general similarity of these structures to one of unequivocal Basketmaker II affiliation recently excavated on Black Mesa in northeastern Arizona (Smiley et al. 1986) suggests that this architectural pattern may have been widespread during the Basketmaker II period. Associated artifacts include manos, choppers, drills, scrapers, flakes, and dart points (Shutler 1961:67). The large, stemmed and corner-notched points are the only potentially diagnostic artifacts described for these assemblages. No remains of cultigens were recovered from any of these sites.

In the same area, excavations at Black Dog Cave (Harrington 1942; Cody 1942) uncovered 30 grass and slab-lined pits in the lowermost levels. Although Schroeder (1953:64) reported that the associated artifacts were similar to those from Cave Dupont, neither he nor Harrington (1942) mentioned the presence of cultigens in the lower levels.· To date, none of the Black Dog Cave material has been described or illustrated in publications, so an independent assessment of the assemblage's Anasazi affiliation is not possible here. Other caves and rockshelters in the Moapa Valley are purported to have contained Basketmaker II materials (Shutler 1961:5), but again, none of these have been reported in any detail. Although it seems plausible that these Moapa Valley sites do indeed date to the Basketmaker II period, their relationship to the Anasazi cultural tradition is open to debate. The cultural temporal affiliation of these sites needs to be independently evaluated through technological analysis of the perishable artifacts, morphological analysis of the projectile points, and direct dating of perishable remains.

To the north of the Moapa Valley in the Beaver Dam Mountains of southwestern Utah, excavations by the Museum of Northern Arizona recovered two radiocarbon samples from roasting pit features dating to the Basketmaker II period: an A.D. 280 date from NA11634 and an A.D. 190 date from NA11500. Both sites are multicomponent base camps with complex stratigraphy and overlapping occupation areas, so the relationship of the dates to the associated artifacts is equivocal. Moffitt et al. (1978) suggest that these sites are affiliated with a terminal Archaic occupation of the area, as evidenced by the Gypsum, "Humboldt Concave Base," and Elko-eared types at the site.

At Willow Beach (Schroeder 1961) and at AZ:B:10:4 (ASM) in the Grand Canyon (Jones 1986b), on the other hand, roasting pit features radiocarbon-dated to the Basketmaker II period have been ascribed to Basketmaker II Anasazi solely on the basis of their temporal placement. Schroeder interpreted materials from his preceramic level at Willow Beach, radiocarbon-dated at 250 B.C., as evidence of a western variant of the Basketmaker II Anasazi occupation, but neither the lithic assemblage nor the roasting pit features are diagnostic of Basketmaker II on the Colorado Plateaus and no evidence of cultigens was recovered at the site. Jones (1986b:324) similarly attributes a preceramic roasting pit at AZ:B:10:4, a rockshelter site in the inner Grand Canyon across the river from Deer Creek Falls, to Basketmaker II Anasazi based on two corrected radiocarbon determinations of A.D. 230 $\pm$ 610 and 380 B.C.-A.D. 210.

The correlation of some of these early formative dates with late Archaic point types, in combination with the frequent occurrence of roasting pits and the location of sites away from arable land, may indicate a persistence of the Archaic culture tradition in the western part of the Strip contemporaneous with the Basketmaker II Anasazi occupation to the east. Alternatively, the sites could represent one portion of an Anasazi Basketmaker II subsistence cycle involving upland and inner canyon hunting and gathering and nonagricultural food processing activities. Although future studies may bear out Schroeder's hypothesis (1961:90) of a variant Basketmaker II Anasazi tradition encompassing the western portion of the Arizona Strip as far west as Willow Beach and the Moapa Valley, it seems prudent to reserve judgement until more complete assemblages from these areas are available for study.

Basketmaker II Settlement and Subsistence. The recognition of Basketmaker II occupations on the basis of material items tells us little about the fundamental cultural characteristics of this period. For example, the degree of reliance on horticulture during this period is of paramount importance for evaluating changes in Anasazi adaptive patterns, but data specifically pertaining to Basketmaker II Anasazi subsistence have only recently been compiled (Aasen 1984; Chisholm and Matson n.d.; Lepofsky 1986; Matson and Chisholm 1986; Reinhard 1984; Reinhard and Jones 1987). Previous models of Basketmaker II adaptation (e.g., Aikens 1966) have relied on extrapolation from settlement pattern data and from uncritical acceptance of the Pecos model of Anasazi cultural evolution. The normative evolutionary model of Anasazi cultural development views Basketmaker II as a transitional stage intermediate between the hunting-gathering Archaic lifeway and the sedentary, village dwelling horticultural pattern of the following Basketmaker III period. Accordingly, Basketmaker II subsistence is assumed to be primarily focused on wild food resources, with cultivated foods providing a supplementary addition to the diet (Aikens 1966; Jennings 1966).

Recent studies by Matson and Chisholm (1986) challenge this traditional view. Review of the coprolite, carbon isotope, and midden evidence from Basketmaker II sites on Cedar Mesa in southeastern Utah indicate that maize comprised the bulk of the Basketmaker II diet, and that there was no significant difference in the amount of corn consumption between Basketmaker II and later periods. These provocative findings will undoubtedly foster additional studies on this important research issue.

At this point, it is impossible to determine whether the data from southeastern Utah and northeastern Arizona are applicable to the Arizona Strip. As discussed in the preceding section, there is still no consensus of agreement regarding the Basketmaker II occupation in the western part of the Strip and the degree to which the initial Formative populations in this area were dependent on cultivated foods. Knowledge of Basketmaker II settlement distributions is still too sketchy to provide a spatial model of resource procurement activities in relation to environmental resources. This particular research issue should receive greater attention in future areal surveys on the Arizona Strip.

Basketmaker II Regional Interaction and Exchange. Current knowledge concerning Basketmaker II regional interaction and exchange systems is virtually nonexistent. Understanding this aspect of prehistoric cultural systems depends in part on being able to define the limits of Basketmaker II occupation on the Arizona Strip. If the occupants of the Moapa-Muddy Valley region were an extension of Anasazi Basketmaker II populations, did this common cultural bond facilitate interaction and exchange with Basketmaker II occupants of the Arizona Strip uplands? On the other hand, if the occupants of the lowland desert regions were affiliated with terminal Archaic hunter-gatherer populations or early Yuman cultures along the lower Colorado River, as implied by Rogers (1945), what was the nature of cross cultural interaction between these desert populations and those of the Arizona Strip?

Shutler (1961) suggests that salt may have been an early exchange commodity from the Moapa Valley, but there is no means to verify his claim since this soluble mineral is rarely preserved in archaeological contexts. Other items, such as obsidian and turquoise, which could provide significant information on Basketmaker II exchange networks, have not been studied in any detail. Archaeologists working in the Arizona Strip need to develop a basic understanding of the types and distribution of exchange commodities across the Arizona Strip during Basketmaker II times, before they can begin to address the organization and function of Basketmaker II exchange systems in a broader cultural context.

Basketmaker III Period, ca. A.D. 400-800

The Basketmaker III stage is generally considered to be a direct outgrowth of the preceding Basketmaker II lifeway (Aikens 1966). Two-handed manos and trough metates came into use, the bow and arrow replaced the atlatl and spear, and plain gray sand-tempered pottery, occasionally decorated with black carbon paint, was manufactured for the first time. Settlements typically consisted of an unformalized arrangement of one to five pithouses and several extramural cists.

The addition of ceramics and the bow and arrow to the existing Basketmaker II cultural inventory are the primary technological developments that set this period apart from the preceding one. These developments undoubtedly had important ramifications in terms of storage and hunting behavior, as well as in terms of the functional role of certain classes of artifacts. For example, the availability of large ceramic vessels during Basketmaker III times provided an alternative to cists in dry caves for long term storage of seeds and perishable items, and reduced the need for basketry canteens and cooking containers. As far as fundamental cultural patterns are concerned, however, the distinction between the Basketmaker II and III periods is relatively insignificant, at least in the eastern part of the Strip where Basketmaker II Anasazi remains have been positively identified. In the western part of the Strip, specifically the Shivwits Plateau, western Grand Canyon, and Grand Wash benches, the relationship between the preceding occupation and the Basketmaker III occupation is still uncertain.

Chronology. The traditional beginning date for this period, A.D. 500, supposedly marks the introduction of ceramics. This date, however, has been recently called into question by a suite of early (pre-A.D. 400) charcoal dates recovered by Thompson and Thompson (1974, 1978) at the Little Jug site south of Mount Trumbull. Six dates ranging between 1850 ± 90 and 1630 ± 90 B.P. (A.D. 10 ± 410) were obtained from pithouses with associated plain gray ceramics. As Thompson et al. (1983:124) point out, the dates from the Little Jug site are comparable to dates from early ceramic sites in the Navajo Reservoir District (Eddy 1961). Although the dates are not in question, the suggestion that they represent the initial date of pottery manufacture in this area (Thompson and Thompson 1974; Thompson et al. 1983:124) remains controversial. As Hobler and Hobler (1978:38) have demonstrated, dead wood suitable for construction (and presumably also for fuel) is frequently 100 to 250 years older than its date of actual use. Given the degree of uncertainty inherent in radiocarbon dating, the Little Jug pithouses and associated ceramics may well date two to three centuries later than the radiocarbon determinations suggest. Nevertheless, it should be noted that radiocarbon dates suggestive of fourth century A.D. occupations have been forthcoming from two other Basketmaker III pithouse sites in the Virgin Anasazi region, one located on the headwaters of the Virgin River near Carmel Junction, Utah, and another situated on the Shinarump Bench approximately 15 miles east of Kanab (Douglas McFadden, personal communication 1988).

Although these dates provide tentative support for pre-A.D. 500 ceramic production on the Arizona Strip, the cumulative data are currently insufficient to support a radical revision of the starting date for the Basketmaker III period. A conservative revision to ca. A.D. 400 is suggested at this time. This chronological issue is clearly in need of additional study. The traditional ending date for the

Basketmaker III period and the beginning of the Pueblo I period is ca. A.D. 700. This date is largely based on Colton's (1952) original estimates for the beginning dates of diagnostic Pueblo I pottery types in the Virgin and Kayenta regions, namely Washington Black-on-gray and Kana-a Black-on-white. Thompson (in Walling et al. 1986:354-355) also assigned an A.D. 700 beginning date to Washington Black-on-gray, noting that the design style is clearly transitional between earlier and later decorated types and overlaps temporally with the preceding local Basketmaker III type, Mesquite Black-on-gray, until ca. A.D. 775 or 800. Within the Virgin area, radiocarbon dating of suspected Basketmaker III sites offers little evidence to confirm or refute the traditional A.D. 700 ending date for this period (e.g., Soule 1975, Westfall 1985). Although some as yet unpublished dates from ceramically dated Pueblo I sites are reported to cluster in the A.D. 700s and 800s (Dalley and McFadden 1985:43), there remains considerable uncertainty as to whether these dates are an accurate reflection of site occupation. Prehistoric use of dead wood and reuse of old beams, the accretional and often overlapping nature of Virgin Anasazi intrasite building sequences, and the uncertainties inherent in radiocarbon dating generally, limit the reliablity of available chronometric information and render it open to multiple interpretations. Meanwhile, recent studies in the northern Kayenta region (e.g., Klesert 1979:31) suggest that the Basketmaker III period continued in that area until A.D. 800 or 850. Other researchers from the same study area (e.g., Plog 1986) characterize the century between A.D. 750-850 as transitional between Basketmaker III and Pueblo I. Although none of these studies employ ceramic types as the primary criteria for assigning sites to a particular temporal span, design attribute analyses in conjunction with tree ring evidence indicate that the design elements traditionally considered diagnostic of Pueblo I types (fine lines, small solid elements, fine dots or ticks, and an overall "open" design treatment) occur in somewhat later contexts than Colton initially estimated (Plog 1986). All of these data, in combination, suggest that the traditional ceramic criteria used to distinguish Pueblo I from Basketmaker III appear a century or more later than Colton originally estimated, or roughly A.D. 800.

Diagnostic Basketmaker III Artifacts. The ceramic diagnostics for this period include plain gray pottery (Lino Gray, Boulder Gray and North Creek Gray), and gray wares painted with Lino-style designs executed in carbon paint (Boulder Black-on-gray, Lino Black-on-gray). Thompson (in Walling et al. 1986:352-353) has assigned new labels to Lino tradition sherds from the Virgin area; he calls the local equivalents Mesquite Gray (for Lino Gray) and Mesquite Black-on-gray (for Lino Black-on-gray). The name changes are proposed "to counter the impression that these types are intrusive" (Walling et al. 1986:353). Dalley and McFadden (1985:42) report that the local gray wares of this period tend towards more "earthy colors," which is suggestive of a poorly controlled or predominantly oxidizing atmosphere, in contrast to the generally well controlled reducing atmosphere employed by Kayenta Anasazi potters during this period. Nevertheless, consistent qualitative or quantifiable differences between the Lino and Mesquite types are imperceptible. Thompson's suggested temporal spans for the Mesquite and Lino types are roughly similar (Walling et al. 1986:355), although he places the beginning date of Mesquite Gray at around A.D. 300 to reflect the dating of Little Jug site. As previously noted, Thompson suggests an A.D. 700 date for the appearance of Washington Black-on-gray; however, he notes that this type is "more clearly a stylistic transition between Mesquite Black-on-gray and St. George Black-on-gray than Kana-a Black-on-white is a transition from Lino Black-on-gray and Black Mesa Black-on-white" (Walling et al. 1986:354). Given the rather fuzzy distinction between Mequite Black-on-gray and Washington Black-on-gray, the occurrence of a few sherds classifiable as Washington Black-on-gray is consistent with a late Basketmaker III temporal assignment.

In terms of trade wares, Lino Gray and Lino Black-on-gray are the only "eastern" ceramic types likely to have been imported to the Arizona Strip prior to A.D. 800. Red wares are not present in the Virgin area at this time (Dalley and McFadden 1985:42), although they were manufactured in the Kayenta and Mesa Verde area as early as A.D. 700 (Breternitz et al. 1974). In the Glen Canyon region, a plain gray type, manufactured with a buff refiring clay and tempered with abundant fine mica (possibly an early version of Snake Valley Gray), frequently co-occurs with Basketmaket III types (Geib et al. 1987). Snake Valley Gray has also been reported in early Formative assemblages in the

Virgin area (e.g., Wade 1967). In a typical Basketmaker III ceramic assemblage, decorated sherds generally comprise a very small percentage of the total assemblage (less than about 5%). Plain gray types continue to dominate Virgin Anasazi ceramic assemblages as late as A.D. 1100 (Nickens and Kvamme 1981), which makes it virtually impossible to distinguish Basketmaker III ceramic components from Pueblo I and early Pueblo II components at this same site using ceramic criteria alone (e.g., Walling et al. 1986:191; Westfall 1985). Even when confronted with apparently limited occupation sites, it may be difficult to distinguish a Basketmaker III occupation from Pueblo I or early Pueblo II use, since on small sites containing only a few sherds, a site's chronological placement may be based on a very small percentage of decorated types, perhaps just one or two sherds.

Projectile point types that commonly occur on Basketmaker III sites include Eastgate Expanding Stem and Rose Spring Side-notched and Corner-notched. Neither of these types occurs exclusively in Basketmaker III contexts, but in conjunction with ceramics, they can provide corroborative evidence of a site's Basketmaker III temporal placement. In the Fremont area, Eastgate Expanding Stem points are frequently found in early (A.D. 500-800) contexts and are generally considered to be diagnostic of this time period (Holmer and Weder 1980:67). This point type also occurs on the Arizona Strip and a similar temporal placement is assumed. Rose Spring Corner-notched points are considered to be an early Formative point style, although they appear as early as A.D. 300 at Cowboy Cave (Jennings 1980; Holmer and Weder 1980:60) and may be at least partly contemporaneous with the Basketmaker II period on the Colorado Plateau (Geib et al. 1987).

Basketmaker III Site Distributions. Within the study area, the evidence of Basketmaker III occupation is difficult to evaluate due to the lack of distinctive temporal diagnostics for this period. As noted above, on small sites exhibiting plain gray ceramics, it may be difficult to judge whether a site is Basketmaker III or later, since plain gray pottery continues to dominate ceramic assemblages well into the eleventh century A.D. Moreover, it is virtually impossible to distinguish Basketmaker III components at multicomponent sites without radiocarbon dating. This situation may partially account for the low numbers of Basketmaker III sites currently recorded on the Arizona Strip.

Despite low frequencies, Basketmaker III habitation sites dating to this period are known from a wide variety of ecological settings across the Strip. Small numbers are recorded on the Paria Plateau (Mueller et al. 1968), in the House Rock Valley (Amsden n.d.), and around the flanks of the Kaibab Plateau (USFS site files). Basketmaker III habitation sites occur in greater numbers along the base of the Vermilion Cliffs between Fredonia and Short Creek (Wade 1967) and on the Shinarump Bench, which extends south from the Vermilion escarpment east of Kanab (Jennifer Jack, personal communication 1987). Thompson (1971b; Thompson and Thompson 1974) identified several Basketmaker III sites on the southern slopes of the Pine Mountains. At least one large Basketmaker III pithouse village is known to exist on the lower Virgin River at the confluence of Beaver Dam Wash. A number of limited activity BMIII sites are reported to occur on the Shivwits Plateau (Shutler 1961), and several of the rock art panels and associated shelters with slab-lined cists in Snake Gulch may date to this period. The only area of the Strip that appears to be truly devoid of Basketmaker III remains is the inner Grand Canyon (Robert Euler, personal communication 1986). The central portion of the Uinkaret Plateau, centering on the Clayhole Wash region, is another area that has not produced evidence of Basketmaker III occupation, however, this lack of recorded sites is likely due to the paucity of archaeological investigations in the area, rather than to an occupational hiatus.

Outside of the project area, Basketmaker III habitation sites are relatively abundant along the base of the Vermilion Cliffs in the vicinity of Kanab (Dalley and McFadden 1985:42 43; Judd 1926; Nickens and Kvamme 1981; Steward 1941; Westfall 1985), and a sizable concentration of Basketmaker III pithouse villages has been documented on the Shinarump Bench east of Kanab (Dalley and McFadden 1985:43). To the north and west, small numbers of Basketmaker III sites are found on Little Creek Mountain (Heid 1982). They are not particularly common along the middle reaches of the Virgin River, although at least one is known from Parunuweap Canyon in Zion National Park (Schroeder

1955:25-33) and one from the vicinity of Virgin, Utah (Billet 1987). Farther to the west, a sizable number of Basketmaker III sites have been recorded on the benches overlooking the Moapa Valley floodplain (Shutler 1961; Soule 1975). These Moapa Valley sites appear to represent the westernmost extent of permanent Anasazi settlement during this period.

Basketmaker III Architecture. Architecture during Basketmaker III appears to be basically similar to that of the preceding period. Pithouses are still the dominant house form. Both shallow and deep (1.5 m+) forms are known. Some pit structures are surrounded by an interior bench, the base of which is typically lined with upright slabs (Dalley and McFadden 1985; Schroeder 1953, 1955; Soule 1975), but others lack obvious benches (e.g., 42Ws329; see Billet 1987). In one pit structure described by Schroeder (1955:29), the encircling bench was partioned by six transverse clay ridges, each one forming the foundation for a roof support post (Figure 35). Round slab-lined cists with paved floors ranging from 1 to 2.5 m in diameter are almost invariably associated with the pit structures (Dalley and McFadden 1985; Aikens 1966). There is no standardized plan to site layouts, and extramural cists may occur in clusters or as isolated features (Dalley and McFadden 1985:42).

Thompson and Thompson (1974, 1978) reported on the excavation of two early Basketmaker III pit structures that differ from previously reported structures in several important respects. One structure was approximately 40 cm deep with a sloping, concave floor and a lateral ramp entry on the east. The second structure consisted of a shallow pit, 15 to 20 cm deep. The prepared clay floor containing a central firepit was encircled by a shallow trench 30 to 40 cm wide and up to 15 cm deep. This latter structure bears a strong resemblance to Basketmaker II structures excavated by Earl Morris at Talus Village near Durango, Colorado (Thompson and Thompson 1978:2). A series of dates on charcoal from the structures suggests that these pithouses and the associated ceramics may date two or three centuries earlier than the A.D. 500 date commonly postulated for the beginning of Basketmaker III on the Arizona Strip. As noted in the previous discussion of Basketmaker II chronology, these dates remain controversial. Additional dating of pre- and post- ceramic Basketmaker sites is needed to resolve this issue.

Basketmaker III Settlement-Subsistence Patterns. The introduction of pottery and trough metates, coupled with the aggregation of scattered habitations into small pithouse clusters with associated storage cists, is generally interpreted as evidence for a greater reliance on horticulture and increased sedentism. This model of increasing dependence on a horticultural subsistence base during the Basketmaker to Pueblo transition is founded more on faith than on hard data. As discussed previously, recent studies by Matson and Chisholm (1986) in the Cedar Mesa region of southeastern Utah suggest that the degree of reliance on cultivated foods did not change dramatically from the Basketmaker II to the Basketmaker III period. Whether this pattern holds true for the Virgin Anasazi region is a subject for future study.

Currently, many scholars assume that horticultural products provided the staples of the diet, with hunting and gathering of wild game and plant foods providing important supplements (e.g. Effland et al. 1981; Geib et al. 1986; Glassow 1972; Jennings 1966; Powell 1983; and others). Beyond these vague ideas, no detailed models of Basketmaker III subsistence strategies have been developed.

Aikens (1966:21) argued that settlement pattern data from the Virgin and Kayenta regions indicated that lowland areas in valley or canyon settings were favored for occupation by Basketmaker peoples of both regions, while highlands were little utilized, if at all. He acknowledged that this settlement pattern could be a reflection of low population density, which obviated the need for occupation of the less well watered upland environments; however, the evidence strongly suggested to him that both the Virgin and Kayenta Anasazi economies were oriented to a similar system of land utilization centered on the cultivation of valley bottom lands (Aikens 1966:21).

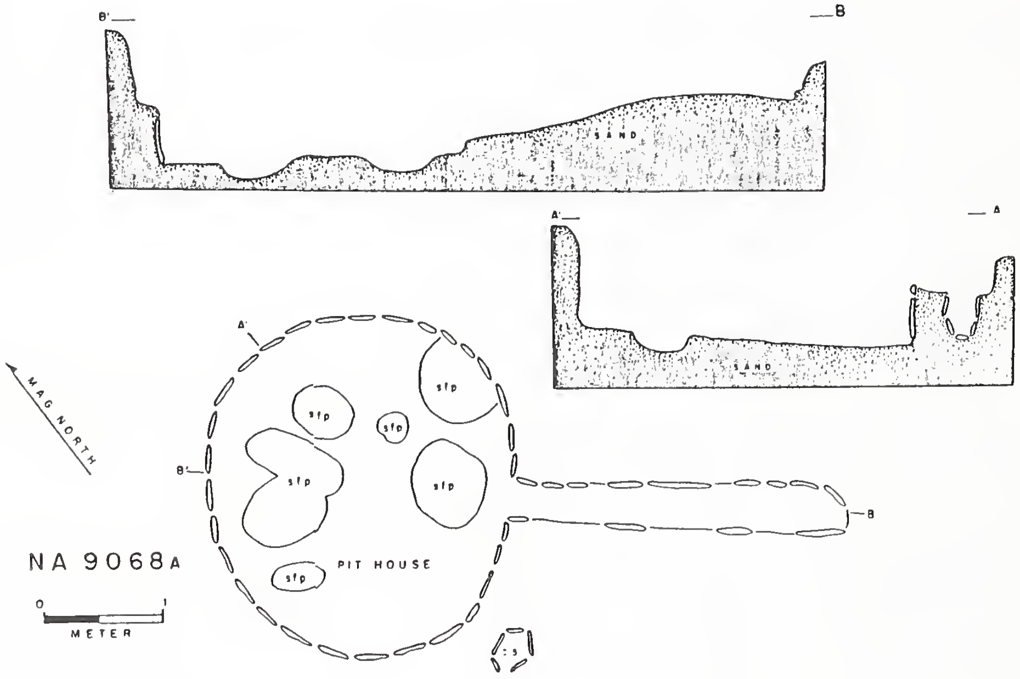


Figure 35. Basketmaker III Pithouse at NA9068A. The site is approximately 5 miles southwest of Fredonia, Arizona. Map courtesy of the Museum of Northern Arizona.

Surveys by Thompson (1970, 1971a, 1971b) in the Tuweep Valley area, Shutler (1961) on the Shivwits Plateau, and Heid (1982) on Little Creek Mountain call Aikens' basic assumptions into question. All of these areas contained Basketmaker III sites situated in upland environments away from well watered valley bottoms. Thompson (1971a:27) does not describe the Basketmaker III sites in the Cove region in detail, although it is clear from other sources (i.e., Thompson and Thompson 1974) that at least some of the sites contain habitation pit structures in addition to extramural slab-lined storage cists. The Basketmaker III sites on the Shivwits Plateau and Little Creek Mountain are identified from surface evidence alone. The lack of obvious Basketmaker III structural features on the Shivwits Plateau led Shutler (1961:8) to conclude that these sites represented hunting and gathering camps, rather than habitation loci. Lipe and Thompson (1979:57) question this general assumption, noting that some sites exhibit sufficient numbers and densities of artifacts to suggest the possibility of subsurface habitation units. Cists are definitiely present on the Little Creek Mountain sites, but the existence of associated habitation structures has not been verified through excavation. The sites are situated along the mesa rim in heavily wooded areas. This setting is similar to that of the early Formative (Basketmaker III-Pueblo I) sites on the Paria Plateau (Mueller 1972:63). Although the evidence is still quite limited, it is clear that Basketmaker III settlement-subsistence patterns are far more complex than Aikens' brief summary indicates, and that utilization of upland environments, perhaps on a seasonal basis, was an integral part of the Basketmaker III subsistence regime. Excavation of Basketmaker III sites on the Shivwits Plateau and other upland areas would presumably help to clarify this issue.

Basketmaker III Regional Interaction and Exchange. Early researchers in the western Great Basin noted the presence of sand-tempered plain gray pottery and black-on-gray sherds in the Las Vegas valley and scattered localities to the west (Duffield 1904; Harrington 1928; Kroeber 1939; Rogers 1929). The presence of these sherds was initially thought to demarcate the western Anasazi frontier (Harrington 1926c). Lyneis (1984:84) disputes this assertion, noting that the westernmost limit of permanent Anasazi settlement was in the Moapa Valley, but she acknowledges that periodic expansion to the west is indicated for specific time periods.

Lyneis (1984:84) maintains that there were two different types of expansion: colonization of outlying oases, presumably for farming and establishment of satellite settlements for the extraction of turquoise. Current evidence for the establishment of outlying farming colonies during the Basketmaker III period is restricted to one small pithouse village with plain gray pottery at Big Springs in the Las Vegas Valley (Lyneis 1984:84). The evidence for establishment of outlying mining settlements during this period is even more tenuous and has led to considerable debate in the published literature over the years.

Early on, Rogers (1929, 1945) noted the presence of Lino Black-on-gray sherds at turquoise mines and scattered locations in the Mohave desert that he attributed to Basketmaker III miners from the Lost City region. Shutler, on the other hand, unequivocally states, "The people of the Muddy River Phase do not seem to have used turquoise and the local mines were not exploited" (1961:68). Shutler's viewpoint seems implausible, given the evidence for turquoise use and exchange by Anasazi during and following this period (Rafferty and Blair 1984).

Turquoise mines in the Halloran Springs area near the Mohave Basin, 125 miles southwest of the Moapa Valley, have produced radiocarbon dates indicating that mining activites took place at that locality as early as A.D. 400 (King 1979). The cultural affiliation of these first (and subsequent) miners remains controversial (Lyneis 1984:85). Leonard and Drover (1980) argue that most of the plain, sand-tempered ceramics recovered from the Halloran Springs locality are the result of Patayan mining activites, rather than Puebloan, although they do acknowledge the presence of Lino Gray ceramics at the site. Using the same evidence, Warren (1982:40) argues that the Halloran Springs site was exploited by Anasazi miners between A.D. 700 and 900. The ceramic evidence suggests that both Anasazi and Patayan were involved in turquoise mining at an early date.

Data concerning Basketmaker III interregional contacts and exchange north and south of the Arizona Strip is also extremely sketchy. The early Fremont manifestations north of the Arizona Strip are poorly known at present, and our knowledge of the Cohonina occupation south of the Colorado River is equally insecure. Neither of these areas has produced much evidence for economic interaction with the neighboring Virgin Anasazi during Basketmaker III times, but this may be more a reflection of archaeological biases than prehistoric reality. Evidence for interaction with the neighboring Kayenta Anasazi is anything but overwhelming. Lino Gray and Lino Black-on-gray are commonly reported from Basketmaker III sites in the Arizona Strip, but current analytical techniques do not allow us to distinguish locally produced ceramics from imported wares. A similar lack of hard evidence pertains to other potentially traceable commodities, such as lithic raw materials. Given the close proximity of Basketmaker III habitation sites along the base of the Echo Cliffs monocline, immediately east of the Arizona Strip (Keller 1978a), and in the House Rock Valley-Paria Plateau area (Amsden n.d.; Mueller et al. 1968; Mueller 1972), it seems logical to infer that some form of exchange between these populations took place, but evidence to support this inference remains elusive.

In the Glen Canyon-Kaiparowits region, there is continuing uncertainty regarding the cultural affiliations of the area's occupants during the Basketmaker III period. Although some researchers have questioned whether the area was even occupied at this time (Jennings 1966; Lipe 1967), recent studies in the Escalante drainage (Geib et al. 1986, 1987) confirm the presence of scattered populations in the region during the Basketmaker III period. Plain gray ceramics are present on several open sites located on the canyon floors of the Escalante drainage system, and one such site produced radiocarbon dates indicating an occupation between A.D. 600 and 850. (Geib et al. 1987). The ceramic assemblages from these sites exhibit a mixture of plain coarse quartz sand-tempered gray wares and polished micaceous gray wares, the latter resembling Snake Valley Gray, plus occasional specimens of Lino Black-on-gray. The source of the sand-tempered gray wares is as yet uncertain, although they do not resemble typical Lino Gray ceramics from the heart of the Kayenta Anasazi territory (Geib et al. 1986:153). The exterior surfaces of these sherds are usually well smoothed or slightly polished, while the interior surfaces are extremely rough, and the sand temper often contains grains of dark angular rock. In many respects, these sherds resemble Steward's (1941) original description of Paria Gray, a type thought to be indigenous to the Arizona Strip during the Basketmaker III period (Colton 1952). If these sherds are examples of Paria Gray, they could provide evidence for contact between the Arizona Strip and the lower Escalante region at a much earlier time than previously thought. Aside from the occasional reported occurrence of such obvious imported commodities as turquoise and seashells (Billet 1987; Shutler 1961; Jennifer Jack, personal communication 1987), evidence for interregional exchange with the Virgin Anasazi during the Basketmaker III period remains meager. Given the dearth of specific data indicative of intra- or interregional trade, speculation on the nature of the exchange system and its effect on other aspects of the cultural system is pointless at this time.

Pueblo I Period, ca. A.D. 800-1000

The standard model of Anasazi cultural development depicts the Pueblo I period as a continuation and elaboration of trends initiated during the preceding Basketmaker III period: aggregation of sites into larger pithouse villages, the development of contiguous masonry and jacal semi-subterranean structures for storage and habitation, and the refinement of ceramic production techniques. Although there is some validity to this model, it overemphasizes change at the expense of continuity. In fact, there seem to be more similarities between Basketmaker III and Pueblo I sites in terms of settlement distributions and technology than there are differences.

The differences between Basketmaker III and Pueblo I sites are manifested primarily in ceramics, site layouts, and architectural patterns. Ceramic changes that occurred during in the Pueblo I period include the addition of new vessel forms (e.g. globular jars with long, flaring necks) and minor changes in painted ceramic design styles. Round, benched, slab-lined pithouses are fairly typical of this period, and a semi-formalized arrangement of deep, slab-lined storage cists in a contiguous arc-shaped pattern is apparent at many sites (e.g., Thompson and Thompson 1980; Dalley and McFadden 1985); however, other styles of pithouses and linear roomblocks are also known to occur (e.g., Jenkins 1981). The extent to which these differences reflect changes in subsistence strategies and socioeconomic organization are as yet undetermined.

Diagnostic Pueblo I Artifacts. As noted above, Pueblo I manifestations on the Arizona Strip are often difficult to distinguish from the preceding Basketmaker III period. Many ceramic and projectile point types are common to both periods. Eastgate Expanding Stem and Rose Spring projectile points are typically found in Basketmaker III-Pueblo I assemblages, along with the ubiquitous Elko points, and ceramic assemblages continue to be dominated by plain gray pottery in the form of large, long-necked ollas and hemispherical bowls. Small quantities of pottery decorated with black paint on an unslipped gray background also occur.

The indigenous decorated types diagnostic of the early Pueblo I period (ca. A.D. 800-950) include Washington Black-on-gray and Boysag Black-on-gray (Walling et al. 1986:352). Although these indigenous types are described as Virgin analogs of the Kayenta Pueblo I type, Kana-a Black-on-white (Walling et al. 1986:352), Virgin Pueblo I types are actually quite different from their Kayenta counterpart. The finely executed lines characteristic of Kana-a Black-on-white are not duplicated on Washington Black-on-white, and the encircling design layouts of Kana-a Black on white (e.g., Beals et al. 1945:95-99) are quite distinct from the bilateral or asymmetrical layouts of Washington Black-on-gray (e.g., Shutler 1961, Plate 49). Furthermore, the Kayenta types generally show greater technical refinement (smoothed, often polished surfaces; well controlled reducing atmosphere; dark and distinct painted elements on even, white surfaces), whereas the Virgin decorated types tend to have coarser surfaces and less finely executed painted decorations on grayish or off-white backrounds. During the latter part of the Pueblo I period (A.D. 900-1000), Washington Black-on-gray underwent stylistic changes; the successor type is known as St. George Black-on-gray. Although commonly considered to be an analog of the early Pueblo II Kayenta type, Black Mesa Black-on-white, many of the design elements (narrow parallel lines, triangular elements ticked with fine dots) and the "open" design execution bear a stronger resemblance to the late Pueblo I-Pueblo II Kayenta type, Wepo Black-on-white (Wilson 1976). Again, there are broad similarities between the Virgin and Kayenta types, but there are also continuing technical and stylistic differences that set them apart.

Ceramic wares from surrounding areas were traded west of the Colorado River into the Kanab and eastern Grand Canyon region during the Pueblo I period (Effland et al. 1981; Douglas McFadden, personal communication 1985). Ceramics manufactured by the neighboring Kayenta Anasazi at this time include neckbanded gray ware jars and vessels decorated with the distinctive Kana-a and Wepo Black-on-white design styles. Deadmans Gray and Floyd Black-on-gray from the Cohonina region west and north of the San Francisco Mountains have been reported from Pueblo I sites in the eastern Grand Canyon region (Hall 1942; Schwartz et al. 1981). San Juan Red ware, which first appeared in the Mesa Verde area during late Basketmaker III, was widely traded among neighboring Anasazi groups during the Pueblo I period, but it apparently did not reach the Virgin area until sometime after A.D. 1000 (Dalley and McFadden 1985:43-44).

Pueblo I Site Distributions. Pueblo I sites are relatively common on the Arizona Strip. The main population centers during this period appear to be concentrated along the lower Virgin River (Jenkins 1981; Shutler 1961), around Pipe Springs (Lindsay and Madsen 1978; Richard H. Thompson, personal communication, 1986; Wade 1967), and on the Shinarump Bench east of Kanab (Douglas McFadden and Jennifer Jack, personal communication 1987). Outside of the Strip, Pueblo I habitations are found in considerable numbers on Little Creek Mountain (Heid 1982) and along the Virgin and its tributaries as far east as Mt. Carmel Junction (Dalley and McFadden 1985:43; Walling et al. 1986). Pueblo I artifact scatters are found in small numbers on the Paria Plateau (Mueller et al. 1968), around the flanks of the Kaibab Plateau (Marietta Davenport, personal communication 1985; USFS site files), on the lower slope of Mount Trumbull (Moffitt and Chang 1978), in the inner Grand Canyon (Euler and Taylor 1966; Jones 1986b; Schwartz et al. 1980) and on the Walhalla, Powell, and Shivwits plateaus (Schwartz et al. 1981; Effland et al. 1981). Most of these latter sites appear to represent short term occupations or specialized activities, rather than habitations.

Pueblo I Architecture and Site Layouts. The Pueblo I period encompasses considerable architectural diversity. Pithouses are usually circular, benched and slab lined, with a centrally located firepit and several shallow subfloor pits (Figure 36). The associated storage features are typically deep (1m+) and floored with slabs or a dense layer of cobble-sized rocks plastered with mud. Some sites consist of a row of contiguous circular or subrectangular cists arranged around a pit dwelling (e.g., Dalley and McFadden 1985:31), while others include one or more large (2.5-m-wide and 3.0-m-long) habitation rooms appended to one end of a string of a storage rooms (Figure 37 through 39). In the latter instances, the habitation rooms are usually semi-subterranean with slab-lined pit walls and jacal or masonry superstructures. Building sequences, as revealed by excavation, suggest a gradual accretion of storage and dwelling rooms over an extended period of time, rather than preplanned settlements (Dalley and McFadden 1985; Walling et al. 1986). Dalley and McFadden (1985:43, and personal communication 1988) consider the former site plan with the round, benched pithouse and contiguous arc of storge cists to be most typical of the Pueblo I period, which they date from A.D. 700-900, while the latter site plan appears to be most common during the early Pueblo II period (ca. A.D. 900-1000/1050). If this temporal patterning in borne out by future research, temporal ordering of sites on the basis of architectural layouts may be possible. On the other hand, if recent research in the Kayenta region is any indication, future excavations on the Arizona Strip are likely to reveal considerably more variability in site plans and architecture than is currently documented for the region. NA 9058, a site located at the confluence of Beaver Dam Wash and the Virgin River illustrates another possible Pueblo I site layout: scattered pithouses with no apparent plan (Figure 40). The pithouses at this site range from 2 m to 6.5 m in diameter, with most measuring between 3.5 and 5 m in diameter. All of the pit structures are basically round, with clay floors, central fire basins, and unlined earthen walls. Peripheral roof supports are embedded in the walls of some structures, but do not demonstrate a common pattern. Although Pueblo II ceramics occur at this site, the major occupation and most of the structures appear to date to the Basketmaker-III Pueblo I period.

Pueblo I Settlement-Subsistence Strategies. Data concerning Pueblo I settlement-subsistence strategies are difficult to evaluate. There are too little data specifically dealing with Pueblo I subsistence and settlement patterns to permit a detailed reconstruction of Pueblo I settlement and subsistence regimes. Nevertheless, some generalizations and alternative models can be offered. Heid (1982) argues that the Virgin Anasazi placed more emphasis on horticulture (as opposed to hunting gathering) during this period. His argument is based on the settlement data from Little Creek Mountain, which show a settlement shift from the mesa rims during Basketmaker III to the central alluviated portions of the mesa top concurrent with an increase in site population during Pueblo I. Heid operates from the premise that the Anasazi practiced a sedentary settlement strategy, a proposition that has become increasingly suspect in recent years (e.g., Powell 1983). The shift to the mesa interior could also be interpreted as a reflection of a shifting settlement strategy towards a seasonal occupation of upland environments concurrent with a lowland occupation along the adjacent river bottoms. More specifically, this settlement pattern could be interpreted as evidence of a spring-summer riverine adaptation, as illustrated by the Red Cliffs site (Dalley and McFadden 1985), and a fall winter upland adaptation as reflected by the Little Creek sites (Heid 1982). This strategy would account for the coexistence of two apparently distinct but contemporaneous adaptive strategies in the Little Creek Virgin River area as previously noted by Dalley and McFadden (1985:158). Although a winter upland, summer lowland settlement pattern might seem inconsistent with annual climatic patterns, it makes sense in terms of maximizing subsistence output and the seasonal availability of critical resources such as fuel and water. Wintering in the wooded uplands provides protection from the weather and an abundant, handy supply of fuel wood; potable water is no problem at this time of year since snow can be melted, and natural catchments are constantly replenished. Movement to the valley bottoms in early spring, after the winter food supply has been exhausted, provides a ready supply of spring greens and water to tide the population over through the spring drought.

A seasonal settlement strategy is also logical from the standpoint of horticulturalists attempting to subsist in an agriculturally marginal, topographically diverse environment (Powell 1983). Recently, Geib et al. (1987) proposed a seasonal settlement model for the Pueblo II occupation of the Glen Canyon region, which posits the movement of people to the resource base, rather than the movement of resources to the consuming population as proposed by Lightfoot (1978) and others (e.g., Effland et al. 1981:48; Rafferty and Blair 1984). As pointed out by Geib et al. (1987:32), an early spring planting in the lowlands would have allowed the Anasazi to harvest green corn by early summer, while crops planted in the uplands after the danger of frost had passed would mature in the fall. The early summer lowland harvest would have provided a resource base to tide the Anasazi over through the fall, while the upland harvest could have been stored in situ for winter consumption and the following year's seed.

This model avoids the problems associated with moving bulky subsistence resources between uplands and lowlands. Instead, populations move in tandem with the seasonal availability of resources. Spring greens and seed plants, such as Indian rice grass (Oryzopsis), could be harvested in the lowlands prior to maturation of the early summer crop, while pinyon nuts, berries, and other late maturing foods could be gathered in conjunction with the early fall upland harvest. In other words, a semi-mobile strategy involving biannual settlement shifts and double cropping may have developed as a strategy for dealing with spring-summer subsistence resource shortages (Geib et al. 1987:33).

Swarthout (1981) has proposed an alternative model based on ethnographic accounts of Southern Paiute settlement-subsistence strategies to account for Anasazi settlement distributions in the western Grand Canyon and lower Virgin River region, including the southern and western margins of the Arizona Strip. This model would have the Anasazi hunting and gathering in the desert canyon environments during the spring, farming in the river valleys during the summer, and hunting and gathering in the uplands during the fall and winter (Swarthout 1981). According to this model, horticultural activities were restricted to valley bottom environments. Following a late summer harvest, the Anasazi moved up on the plateaus to hunt deer and gather pinyon nuts. They remained in the uplands subsisting on wild foods and stored crops until early spring. This model of a seasonally transhumant settlement-subsistence system is not well supported by the archaeological record. Although there are numerous examples of Anasazi roasting pits and other nonstructural sites in the Virgin and Beaver Mountains (Ellis 1982; Moffitt et al. 1978) and in other areas surrounding the lower Virgin and Moapa River Valleys, relatively few of these sites exhibit the density or diversity of artifacts normally associated with a habitation function. As Rafferty and Blair (1984:159) point out, there is little need to postulate a seasonal relocation of the population to these areas anyway, since the majority of such sites are within one days' traveling distance of the Moapa Valley settlements. Nevertheless, there are some early Formative Anasazi sites on the Arizona Strip, such as Antelope Cave, that could be interpreted as representing one facet of a logistically organized, seasonally mobile settlement strategy (Binford 1980). Other nonstructural sites with abundant sherds and lithics, groundstone, and charcoal-stained soil have been recorded on the Shivwits Plateau (Baldwin 1978; Shutler 1961; Lipe and Thompson 1979), which might also represent the remains of seasonal (late summer fall) hunting and gathering base camps. Only a handful of nonstructural Virgin Anasazi sites have been excavated, however, and even fewer sites have been investigated with an eye towards detecting seasonal use patterns (but see Jones 1986b; Westfall 1987b), so there is little excavation data to support or refute Swarthout's model at the present time.

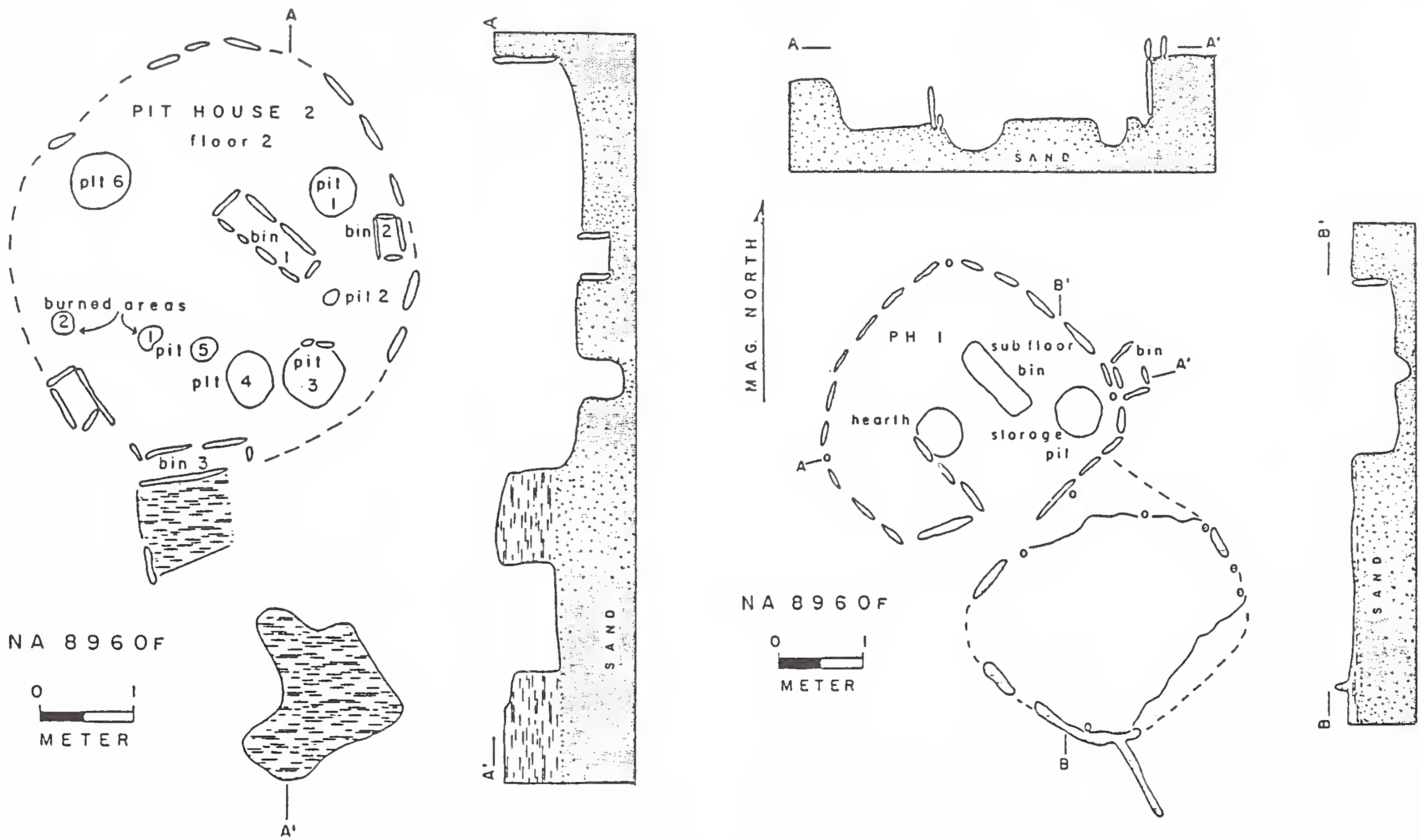


Figure 36. Plan Views of Pueblo I-early Pueblo II pithouses at NA8960F. Map courtesy of Museum of Northern Arizona.

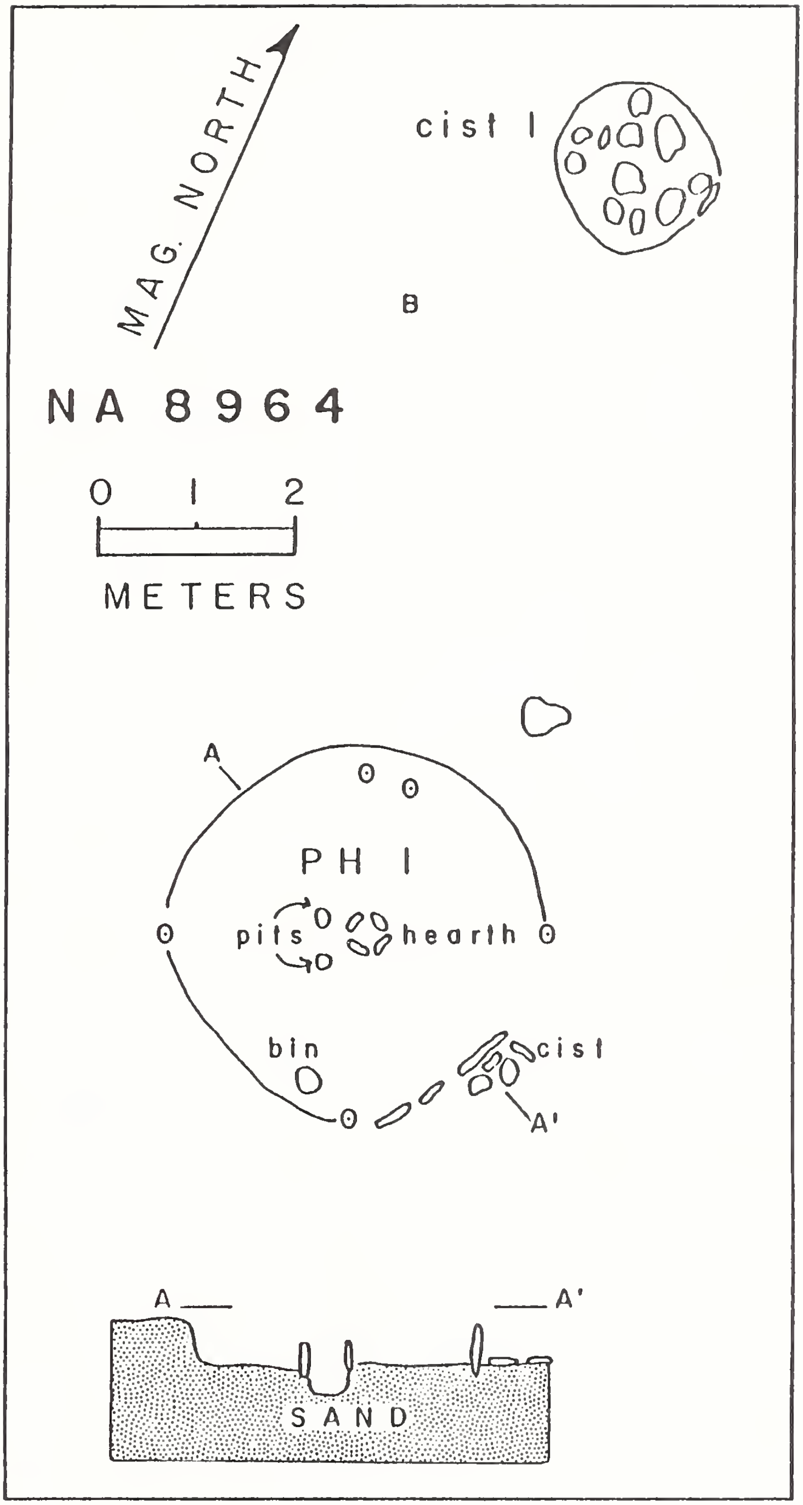


Figure 37. Plan View of a Pueblo I-Early Pueblo II Pithouse at NA8964, Approximately 3 Miles Southwest of Fredonia, Arizona. Map courtesy of Museum of Northern Arizona.

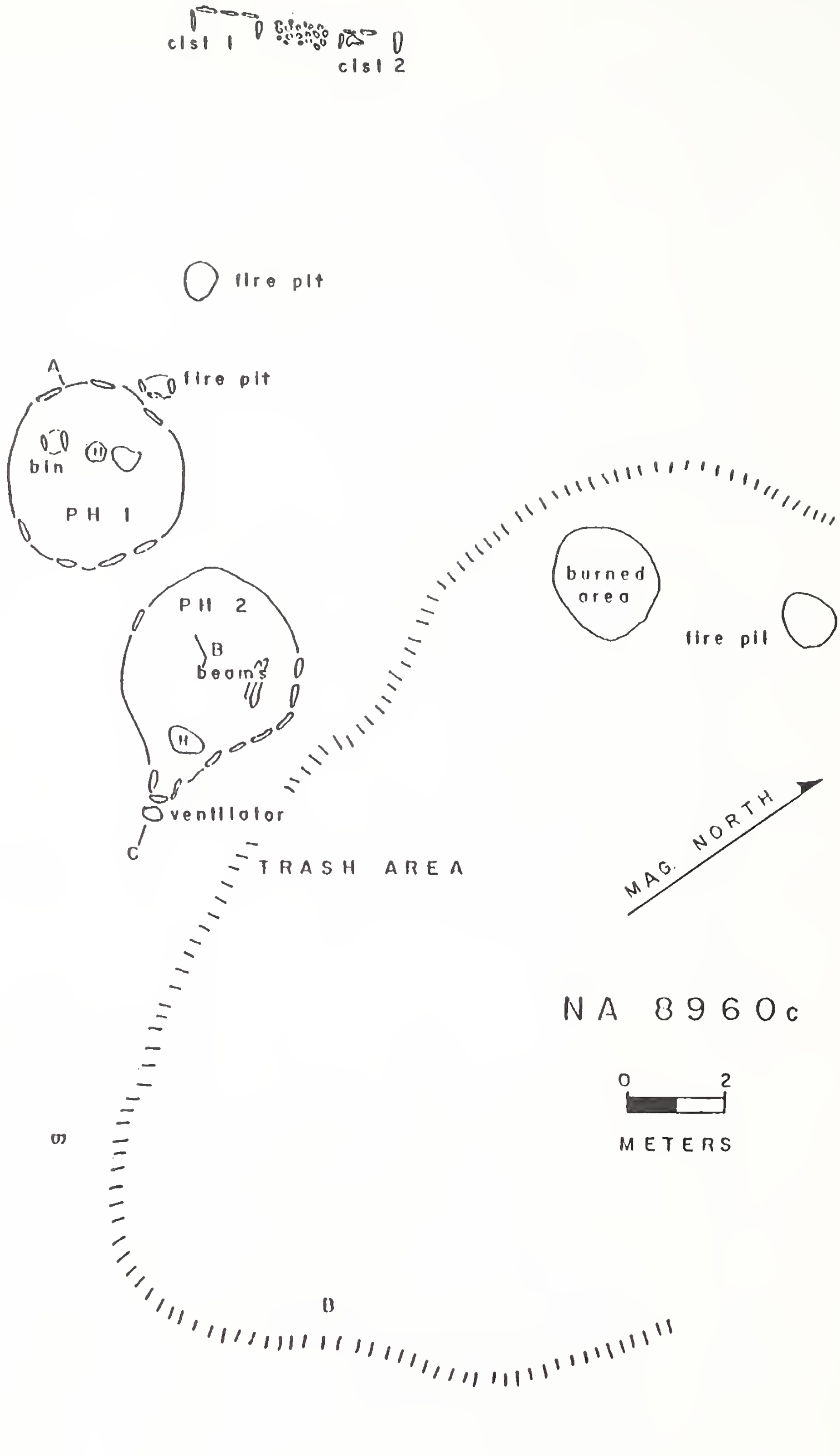


Figure 38. Plan View of NA8960C, a Pueblo I-Early Pueblo II Habitation Site, Approximately 2 Miles Southwest of Fredonia, Arizona. Map courtesy of Museum of Northern Arizona.

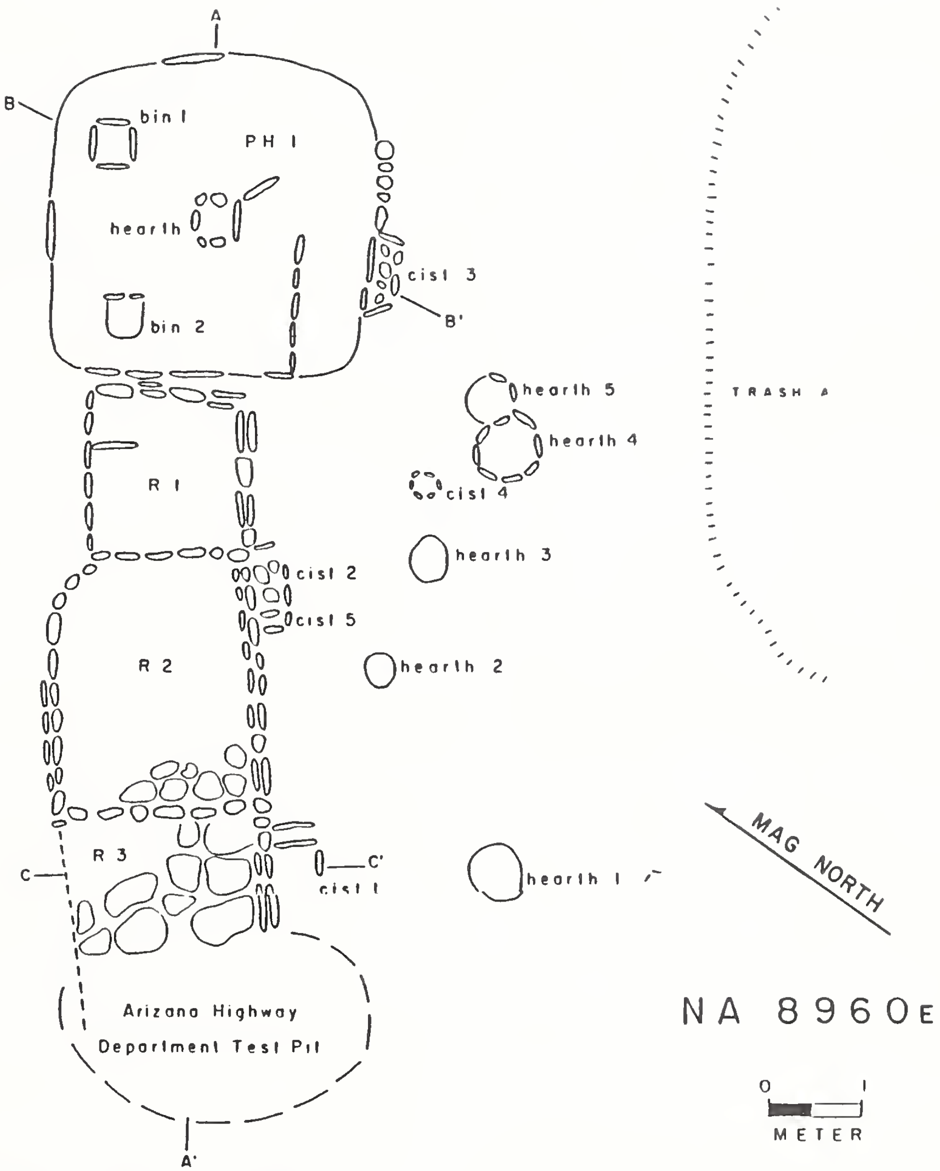


Figure 39. Plan View of NA8960E, a Late Pueblo I-Pueblo II Site, Approximately 2 Miles Southwest of Fredonia, Arizona. Map courtesy of the Museum of Northern Arizona.

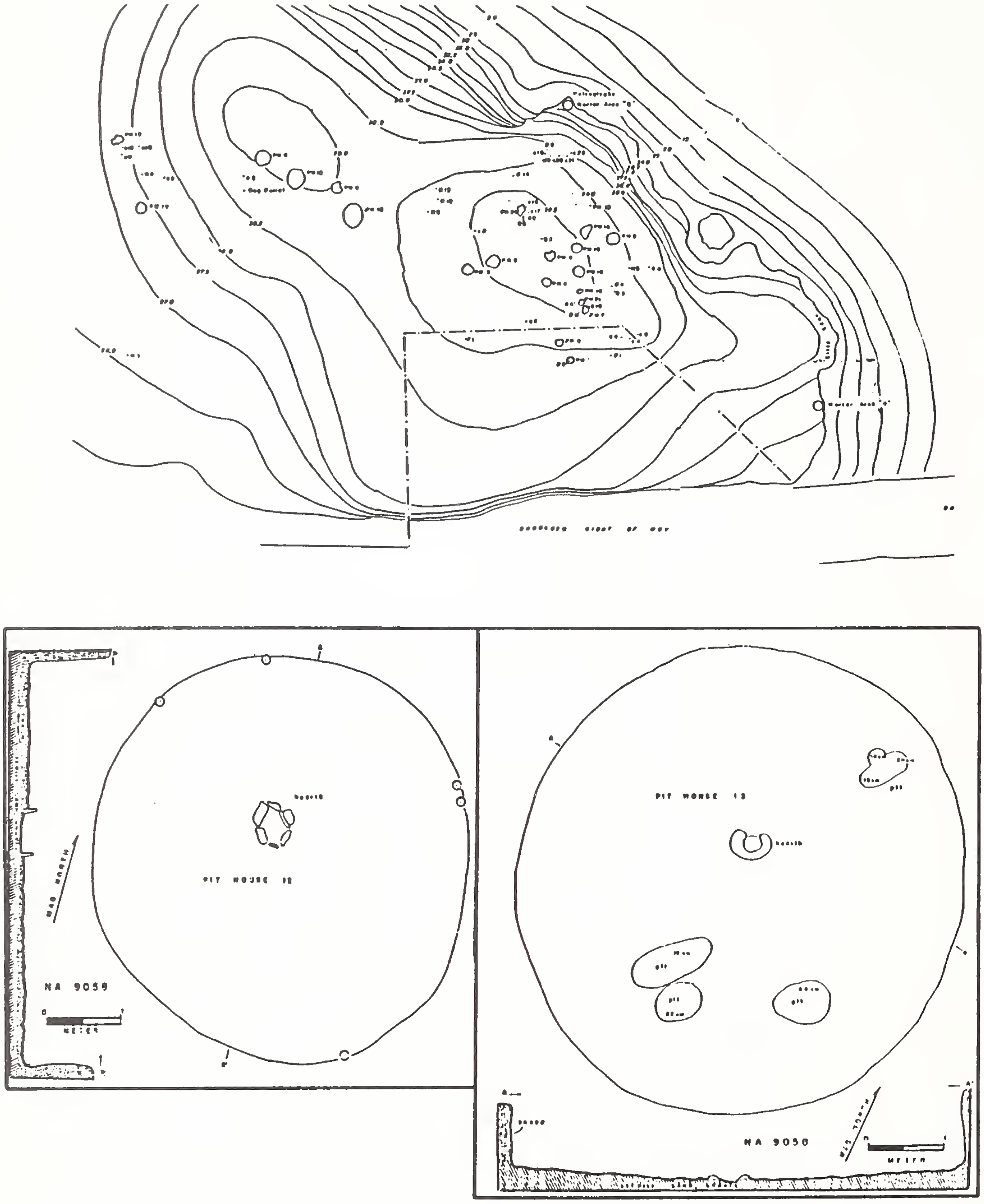


Figure 40. Site Layout and Examples of Pithouses at NA9058, a Pueblo I-II Pithouse Village at the Confluence of Beaver Dam Creek and the Virgin River near Littlefield, Arizona. Map courtesy of the Museum of Northern Arizona.

Neither of these Pueblo I seasonal settlement-subsistence models necessarily contradict the summer upland, winter lowland settlement strategy proposed by Schwartz et al. (1981:129) for the A.D. 1050-1150 period in the eastern Grand Canyon region. As already noted, the evidence for a Pueblo I occupation of the Walhalla Plateau-inner Grand Canyon area is quite limited and survey data suggest that these areas were not intensively used for horticulture during this period (Schwartz et al. 1981:174; Effland et al. 1981). Furthermore, this model does not necessarily rule out the possibility of a year-round settlement strategy in optimal areas of the Strip, such as the Pipe Springs -Short Creek areas or the Shinarump Cliffs. Relative abundance of perennial springs and proximity to arable land, in conjunction with a moderate elevation and ready access to adjacent wooded uplands, may have obviated the necessity of seasonal mobility in these more optimal environments.

Pueblo I Interregional Interaction and Exchange. Although there is considerably more information for this period relative to the preceding ones, data concerning Pueblo I regional interaction and exchange on the Arizona Strip are still relatively meager. This less than ideal situation is largely due to a lack of information specifically concerning the period from A.D. 800-1000. For example, although Harrington's excavations in the Lost City region produced abundant examples of imported shell and turquoise, the temporal context in which these items occurred is largely obscured (Shutler 1961). Regrettably, few of the recent excavation projects dealing with Pueblo I sites on or adjacent to the Arizona Strip (Dalley and McFadden 1985; Jenkins 1981; Walling et al. 1987) have produced substantial additional evidence pertaining to this aspect of Pueblo I Virgin Anasazi culture. Thus, exchange of the various items included in the following discussion should be viewed as a series of hypotheses subject to future testing.

According to Shutler (1961:68), turquoise became an important commodity among the Anasazi of the Muddy River region during the Lost City phase (A.D. 700-1100). Both he and Lyneis (1984:85) are vague about the timing of Virgin Anasazi turquoise exploitation. Warren (1982:40), on the other hand, maintains that the Halloran Springs deposits (and presumably other turquoise localities in the vicinity) were mined by the Anasazi between A.D. 700 and 900. At this point, all that can be said with certainty is that turqoise was definitely imported into the Virgin territory during the Pueblo I period. The cultural affiliation(s) of the importers, the nature of the Great Basin-Southwestern exchange system that allowed its importation, and the manner by which turquoise was distributed through the Virgin Anasazi cultural system have yet to be established.

Information concerning ceramic exchange during Pueblo I remains limited. The abundance of olivine-tempered wares in the Lost City area beginning around A.D. 950 (Lyneis 1986b:57) seems to reflect a high degree of intraregional interaction at this time. Weide's (1978) preliminary x-ray defraction study of the olivine in ceramics from the Lost City region demonstrated that the temper was not procured locally. Although his preliminary x-ray defraction analyses were inconclusive regarding the precise origin of the temper, circumstantial evidence indicated a source locality in the vicinity of Mount Trumbull. Preliminary analyses by Lyneis (personal communication 1987) suggest that temper, rather than finished vessels, was being imported to the Moapa Valley settlements. Salt, turquoise, shell, mesquite beans, and cotton or other agricultural products are some of the most likely items traded to the inhabitants of the Mount Trumbull area in exchange for this commodity. In the eastern portion of the Strip, ceramics diagnostic of the Kayenta Anasazi occasionally are found on Virgin Anasazi sites. These vessels are readily distinguished from indigenous counterparts by paste and temper attributes (compact, low-iron clays and clean, quartz sand temper), as well as by stylistic embellishments. Small quantites of Kana-a Black-on-white ceramics are reported from the Powell Plateau (Effland et al. 1981) and from sites in the vicinity of Kanab, Utah (Douglas McFadden, personal communication 1985). Examples of Kana-a Neckbanded vessels are also known from the Kanab area, although they are uncommon (Douglas McFadden, personal communication 1985). In general, it appears that there was a low level exchange of Kayenta Anasazi ceramics during this period, but the exchange seems to have been an important element of the Virgin Anasazi economy.

Along the base of the east slope of the Kaibab Plateau and on the Walhalla Plateau (Hall 1942; Schwartz et al. 1981), a few campsites with a mixture of Pueblo I-early Pueblo II Anasazi types and San Francisco Mountain Gray ware occur. The occurrence of Cohonina ceramics on the north rim of the Grand Canyon is probably indicative of trade contacts between the Virgin Anasazi and the Cohonina, rather than of an indigenous Cohonina presence. At Unkar Delta, however, Schwartz et al. (1980) found that Cohonina ceramics dominated the assemblages of the earliest sites; therefore, they attributed these sites to the Medicine Valley phase of the Cohonina occupation sequence. Schwartz and his colleagues may be correct in assigning the earliest Formative use of the Unkar Delta to intermittent occupation by the Cohonina, but an alternative scenario, in which the Cohonina and Anasazi used the Unkar Delta as a neutral meeting ground for the exchange of goods seems equally plausible. In this context, the Cohonina plain wares recovered from the Delta could have served as containers for traded commodities such as seeds, paints, or salt.

Obsidian was another valued commodity that may have been traded to the Virgin Anasazi by the Cohonina during Pueblo I. Preliminary trace-element studies of obsidian from two sites on the North Kaibab Ranger District of the Kaibab National Forest confirm the use of the Government Mountain and Mount Floyd sources by the Anasazi occupants of this area, although the precise temporal context of these materials (Pueblo I or Pueblo II) is uncertain (Lesko 1987). Trace element studies of diagnostic Pueblo I artifacts (e.g., Eastgate Expanding Stem points) or obsidian debitage from single component Pueblo I sites are needed to establish whether obsidian from one or both of these sources was traded to the Virgin Anasazi during this period. As yet, no attempt has been made to relate evidence for trade and interregional interaction to more general models of prehistoric exchange systems. Although several models derived from studies elsewhere in the Southwest have recently been incorporated into discussions of Virgin Anasazi archaeology, (e.g, Effland et al. 1981; Larson 1983; Lyneis 1984; Rafferty and Blair 1984; Westfall 1987b), they tend to be highly speculative and are based on a paucity of hard data. Inasmuch as these models are largely directed at explaining the role of exchange during Pueblo II times, they will be treated in the following discussion of that period.

Pueblo II Period, ca. A.D. 1000-1150

Pueblo II is probably the best known period in the Arizona Strip. More site components are dated to this period than any other. In large measure, this increase in components may be due to increased utilization of the uplands at this time, perhaps in response to improved climatic conditions, which made dry farming feasible in previously unproductive areas (Euler et al. 1979). Certainly, the appearance of scattered terraced garden plots, check dams, and other agricultural features during the latter part of this period (Schwartz et al. 1981; Jones 1986a; Westfall 1987b) indicates that dry farming was an important activity in the uplands. Other factors that have been suggested to account for the apparent increase in sites during this period include in situ population growth (Aikens 1966; Mueller 1972) and migration from the neighboring Kayenta region into the eastern portion of the Strip (Plog 1979; Effland et al. 1981). Changes in settlement- subsistence strategies, which resulted in the creation of more structural sites over a relatively short period of time might also account for this phenomenon. The pros and cons of these various arguments are discussed in greater detail below.

Diagnostic Pueblo II Artifacts. Pueblo II Virgin Anasazi ceramics are characterized by bold, blocky designs, narrow stripes, and hatchures painted in black on an unslipped gray or slipped white background. St. George Black-on-gray is the earliest indigenous Pueblo II decorated type, followed by North Creek Black-on-gray, Hurricane Black-on-gray, Virgin Black-on-white, Mount Trumbull Black-on- gray, and Moapa Black-on-gray. These latter types appear to date after A.D. 1050. Indigenous red wares, the so-called Little Colorado Series of San Juan Red ware (Abel 1955), seem to appear about A.D. 1050 (Dalley and McFadden 1985). The latest indigenous Pueblo II types, Washington Corrugated and Nankoweap Polychrome, are indicative of the post A.D. 1100 period.

Corrugations on utility jars and bowl exteriors are important diagnostic ceramic attributes for distinguishing this period from the preceding one. Several recent studies (Nickens and Kvamme 1981; Dalley and McFadden 1985; Ambler 1985) date the onset of corrugation to after A.D. 1000, although the precise date for the appearance of this technique remains somewhat speculative. Based on a small number of radiocarbon determinations from sites in the Moapa Valley, Lyneis (1986b:57) postulates a beginning date of ca. A.D. 950 "or slightly later" for the start of corrugation. At the Kanab site, two radiocarbon determinations overlapped in the A.D. 1040-1100 range. The site produced only one corrugated sherd out of 11,000 (from the surface), which led Nickens and Kvamme (1981:68) to suggest that corrugation was not present in the Virgin area until ca. A.D. 1100. Excavations at the Red Cliffs site in southwestern Utah revealed a ceramic assemblage similar to the one from the Kanab site, although with more Pueblo I types and no red wares. Radiocarbon determinations suggested an occupation range somewhere between A.D. 850 and 1100 (Dalley and McFadden 1985:44-45). Again, the lack of corrugated wares led the authors to speculate that this technique did not appear in the Virgin area until after the mid-eleventh century. Ambler's (1985) review of the tree-ring evidence from single component Kayenta Anasazi sites led him to conclude that Tusayan Corrugated was not produced in any abundance until after A.D. 1020. This is 70 years later than the A.D. 950 beginning date originally proposed by Colton (1952).

The relative frequency of corrugated versus plain gray sherds may also be of temporal importance. In the Kayenta region, Lino Gray and Kana-a Neckbanded are the dominant utility types until the beginning of the eleventh century, when there is a radical shift to the use of corrugated types. By A.D. 1040 or 1050, the ratio of corrugated to plain utility wares is more than ten to one (Ambler 1985:48). In the Virgin area, corrugated sherds are always less numerous than the plain gray types, but there appears to be a steady increase in corrugated wares through time (Jenkins 1981; Lyneis 1986b:56). Hayden (1930:72) originally noted that corrugated wares constituted approximately 69 percent of the sherds recovered at Mesa House; however, Lyneis (1986b:58) is of the opinion that Hayden's findings were biased by selective sampling. She suggests that 40 percent is a more reliable estimate of the proportion of corrugated sherds at Mesa House phase (late Pueblo II) sites in the Moapa Valley. These preliminary findings indicate that the relative frequency of corrugated to plain wares may be important for determining the temporal placement of sites throughout the Arizona Strip during the Pueblo II and early Pueblo III periods.

Following the initial seriation work of Olson (1979), several scholars have examined the temporal significance of temper constituents in ceramics from the Moapa and lower Virgin River valley (Acker 1983; Jenkins 1981; Larson and Olson 1984; Lyneis 1986b). They note shifts in the proportion of certain temper types, particularly olivine and quartz sand, which they view as potentially significant temporal markers. In the Moapa Valley during the Pueblo II period, the percentage of olivine temper increases to more than 30 percent, then declines to less than 5 percent (Lyneis 1986b:58). The applicability of these percentage changes to areas outside the Moapa Lower Virgin River area has yet to be demonstrated, but the initial results show promise as a supplementary means of distinguishing Pueblo I and early to middle Pueblo II sites from later Pueblo II components.

Walhalla Gray and White wares (Marshall 1979) were manufactured for the first time during the (middle?) Pueblo II period. These wares are often considered to be synonymous with the Shinarump wares (Effland et al. 1981; Balsom 1984), which Colton (1952:59) dated to the Pueblo III (post A.D. 1100) period. The Shinarump label currently subsumes such a wide range of ceramic variability, however, that the name no longer retains its original meaning as defined by Colton (1952; see McPherson 1978; Moffitt and Chang 1978; Geib et al. 1986). The Walhalla wares may be local variants of the Tusayan series (Robert C. Euler, personal communication 1986). They are distinguished from the latter by their iron-rich, dark firing clay and crushed sandstone temper. Sherds of these wares are frequently subvitrified and exhibit a purplish or reddish brown surface color indicative of poor control during firing. They appear to be indigenous to the eastern part of the Strip (Schwartz et al. 1980:127; Wilson 1985).

Ceramically, the early Pueblo II period in the Kayenta Anasazi "heartland" is characterized by an abundance of Black Mesa Black-on-white and Medicine Black-on-red ceramics. Although these Kayenta types occur relatively often in the Arizona Strip, they are usually associated with later types such as Sosi Black-on-white, Dogoszhi Black-on-white, and Tusayan Black-on-red, indicating the vast majority of Pueblo II Kayenta trade wares came into the area sometime after A.D. 1050. By A.D. 1090, Sosi Black-on-white and Dogoszhi Black-on-white became the predominant decorated types in the Kayenta region (Ambler 1985). Sites with a predominance of these late Pueblo II ceramics are particularly well represented in the southern and eastern portions of the Arizona Strip.

Characteristic projectile point types of the Pueblo II period include Parowan Basal-notched and Bull Creek (Holmer and Weder 1980). The Bull Creek point is common in northeastern Arizona and southeastern Utah, where it occurs at both Kayenta and Fremont sites. This point type seems to be less common west of the Paria River, but it is not unknown there. In contrast, Parowan Basal- notched points are the dominant projectile point type found on Pueblo II-III sites in the Parowan Fremont and Virgin Anasazi areas. Holmer and Weder (1980:64) suggest a starting date of A.D. 900 for this type in the Virgin area, but it is not common until after A.D. 1000.

Pueblo II Site Distributions. During the Pueblo II period, the Virgin Anasazi expanded into every potentially arable location. Sites attributed to Pueblo II Virgin Anasazi horticulturalists have been recognized as far east as the Kaiparowits Plateau (Gunnerson 1959) and as far west as the Las Vegas Valley of southern Nevada (Shutler and Shutler 1977). Pueblo II habitation sites are common across the entire Arizona Strip, except in the inner grassland areas and broad sage valleys of the central Kanab and Uinkaret plateaus, where site densities are consistently low during all time periods; however, even these seemingly uninviting areas were utilized for agriculture to a limited extent during this period, as shown by the cultigens and ceramics recovered from the Pueblo levels in Antelope Cave (Cutler and Blake 1980; Janetski and Hall 1983). In general, the areas that were occupied during the Pueblo I period continued to be occupied during the following Pueblo II period. In addition, a number of upland and inner Grand Canyon areas, which were only sparsely occupied prior to Pueblo II times, show a dramatic increase in site numbers beginning around A.D. 1050. Pueblo II site concentrations are found on the Paria, Walhalla, and Powell Plateaus, the eastern and western flanks of the Kaibab Plateau, the southern and eastern rims of the Kanab Plateau (particularly around the heads of tributary drainages feeding into Kanab Creek), around Mount Trumbull, and in virtually every tributary canyon of the Colorado River with perennial water and patches of arable land.

Architecture and Site Layout. Both within and outside of the Arizona Strip, Pueblo II sites typically contain one to three small masonry surface living rooms and associated storage structures. Habitation rooms may be either fully subterranean, semi-subterranean, or surficial, and may occur either as isolated units or as extensions of the contiguous storage structures. Storage and habitation rooms are often characterized by different construction techniques; for example, full height masonry walls and slab floors are typical of storage rooms, while jacal superstructures and clay floors are generally associated with habitation structures. The more substantial storage feature construction indicates a continuing concern for the protection of stored produce. Thompson (in Walling et al. 1986:22) defines three prominent forms of habitation rooms during this period: a continuation of the relatively deep, round Pueblo I pithouse supported by peripheral roof supports or possibly a cribbed superstructure, a second round pit structure of variable depth surrounded by a masonry wall, which rests on the original ground surface of the pit, and an essentially surficial circular or ovoid room surrounded by masonry walls. To this list must be added rectangular and sub-rectangular surface rooms constructed of masonry, jacal, "turtlebacks," or adobe (Harrington et al. 1930; Judd 1926; Wade 1967). The differences in construction techniques are probably more indicative of differences in locally available resources, rather than temporal or ethnic preferences (Walling et al. 1986:23).

A variety of site layouts occur during this period. Small PII sites range from a single, round, semi-subterranean pithouse associated with a few rectangular storage rooms and extramural features to a more formal arrangement consisting of a row (often curving) of contiguous subrectangular storage rooms with a larger oval shaped habitation room appended to one end. A combination of these layouts is exemplified at the Pinenut site, AZ:B:6:44 (ASM) (Figure 41; Westfall 1987b). Variations on the latter pattern are illustrated by two other excavated sites near Pipe Springs (Figure 42, 43; Wade 1967). A third architectural pattern, which appears to be more or less confined to the mid to late Pueblo II period (ca. A.D. 1050-1150) is that of an isolated, linear or rectangular, one to four room masonry surface structure. One room may contain a hearth, indicative of a habitation function, while the others are devoid of floor features and are assumed to have been used for storage. This last site type is particularly common in the upland areas of the eastern part of the Strip (Walhalla, Powell, Paria and eastern Kanab plateaus and the rim of Marble Canyon). These small surface structures are sometimes interpreted as seasonally occupied farmsteads (Jones 1986a; Westfall 1987b; Walling et al. 1986:23).

Large sites containing a dozen or more rooms are relatively common during this period, although they are less numerous than the two to four room habitation sites. The larger sites, which may contain up to 30 rooms, are often C- or U-shaped, but linear, L-, V-, and E-shaped layouts are also known. The linear and L- shaped forms seem to be particularly well represented in the eastern portion of the Strip, but they are not confined to that area. A relatively high number of storage rooms in conjunction with the greater density and diversity of artifacts typically found at these larger pueblos has been interpreted as evidence that these sites functioned as intraregional redistribution centers (Effland et al. 1981; Heid 1982; Westfall 1986).

An impressionistic examination of survey site plan maps and excavation data from the general project area indicates a typical storage-to-habitation room ratio of about 4 to 1. This is more or less substantiated by the Powell Plateau survey data, which indicates that approximately 75 percent of the surface rooms appeared to be storage facilities based on their narrow width (less than 2 m) (Effland et al. 1981:29). The ratio of storage to dwelling rooms at these large sites appears to be about the same as for the smaller unit pueblos (Effland et al. 1981).

No discussion of Pueblo II architectural patterns is complete without mention of the kiva. The presence or absence of kivas among the Virgin Anasazi has been a subject of continuing debate (Schroeder 1955; Aikens 1965; Effland et al. 1981). There is little question that kivas were constructed in the eastern portion of the Arizona Strip territory during the late Pueblo II period, but whether or not they represent an indigenous Virgin Anasazi development or resulted from an intrusion of Kayenta Anasazi migrants from the southeast remains unanswered. Two kivas were excavated at Unkar Delta, one was uncovered at the Bright Angel site in Grand Canyon (Schwartz et al. 1979, 1980), and Aikens (1965) identified a probable kiva at Bonanza Dune in Johnson Canyon. None of these kivas exhibited the key-hole shape or formal arrangement of floor features common to many late Pueblo II kivas in the Kayenta region, but they were clearly distinguished from other structures at the sites by being fully subterranean and masonry-lined. In addition, the kiva at Bonanza Dune and one at Unkar Delta contained loom anchor holes (Aikens 1965:28; Schwartz et al. 1980:294). This latter feature is common to many late Pueblo II and Pueblo III Kayenta kivas. Douglas McFadden (personal communication, 1986) reports that there are other good examples of late Pueblo II kiva architecture in the eastern Virgin area. In pre-A.D. 1050 contexts, the evidence for kiva architecture is less secure. Excavation of a late Pueblo-I early Pueblo II C-shaped pueblo in Zion National Park (Schroeder 1955) revealed a pit structure situated in front and to the south of a circular arrangement of storage and habitation rooms, a characteristic kiva location (Smith 1952). Floor features included a central alignment of a ventilator, deflector, clay-rimmed fire basin, slab-lined subfloor vault, and ash pit, as well as several other subfloor

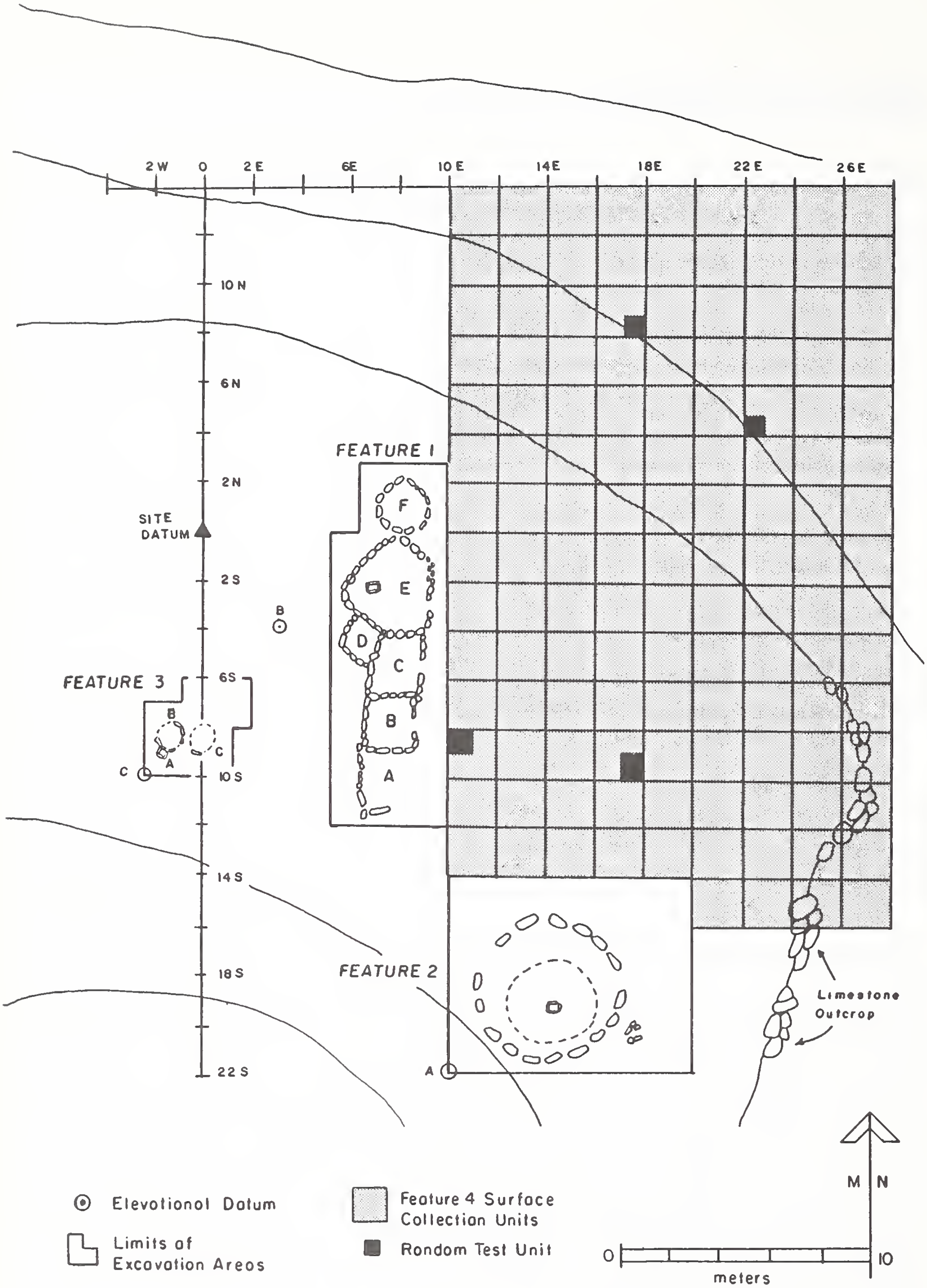


Figure 41. Site Plan of the Pinenut Site, AZ B:6:44 (ASM), a Predominantly Pueblo II Site on the Kanab Plateau. Map courtesy of Abajo Archaeology.

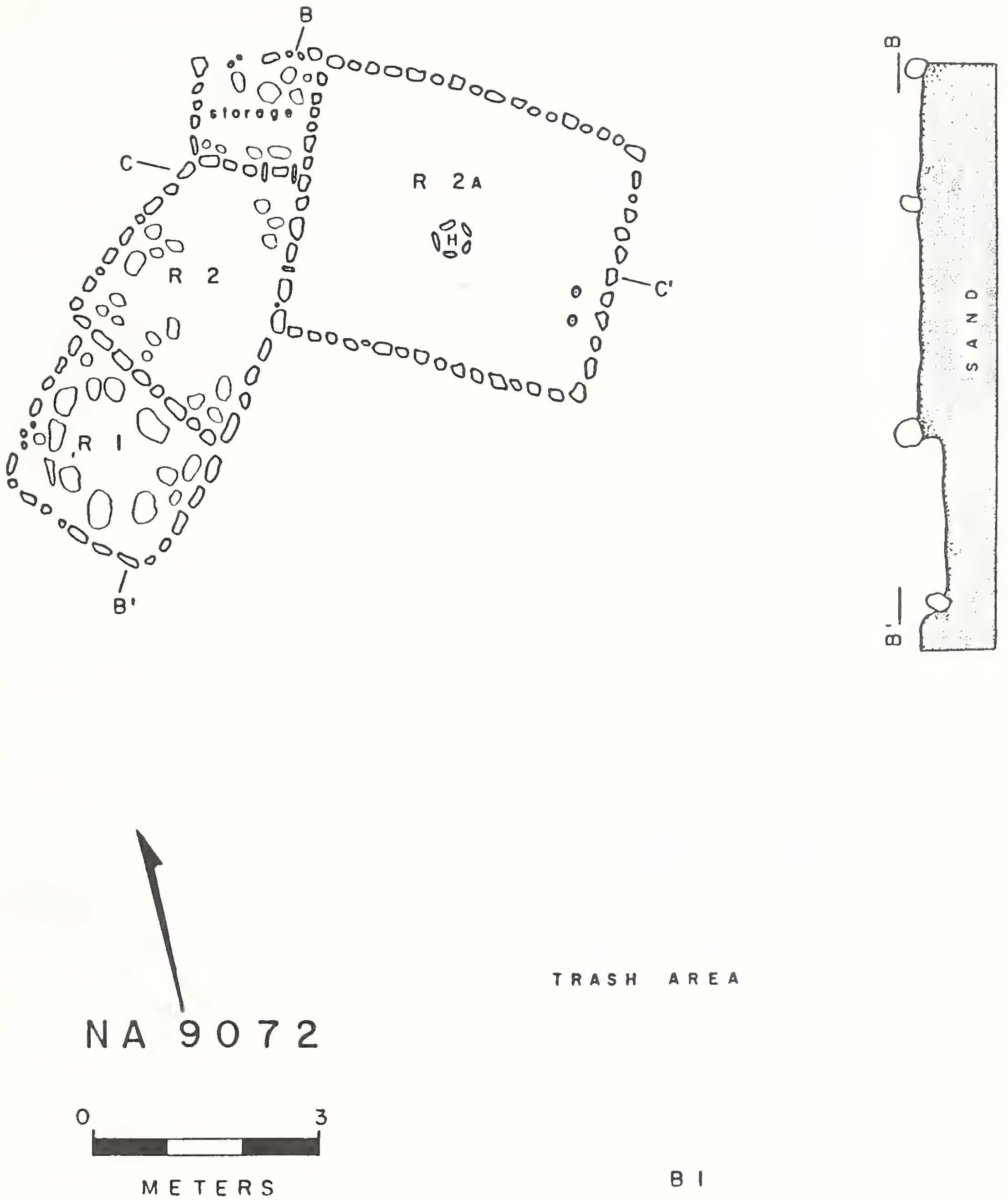


Figure 42. NA9072, a Pueblo II Habitation Site Near Pipe Springs, Arizona. Map courtesy of the Museum of Northern Arizona.

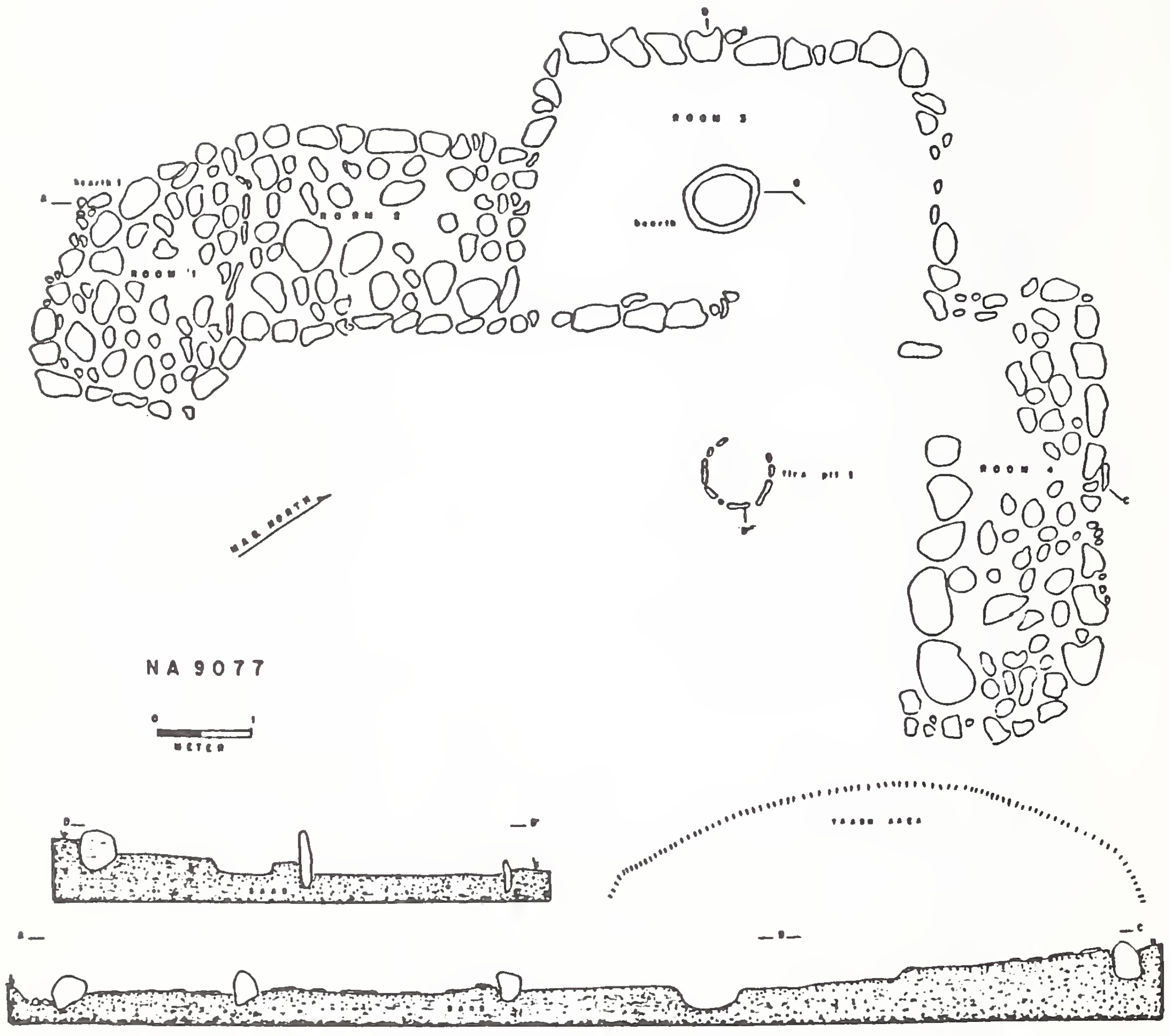


Figure 43. NA9077, a Pueblo II Unit Pueblo Approximately Five Miles West of Pipe Springs, Arizona. Map courtesy of the Museum of Northern Arizona.

pits and four small holes that might have been loom anchors. The structure was completely encircled by a low, slab-lined bench. The bench was partitioned by six clay ridges in which six roof support posts had been embedded. The upper walls consisted of numerous upright posts embedded along the outside of the bench, bound with cross poles to form a wooden lattice plastered over with mud. As noted previously, this style of benched pithouse occurs in late Basketmaker III contexts, and seems to be the predominant style of pithouse during the Pueblo I period. Aside from its position in front of the main roomblock, the most kiva-like aspect of structure was its "obvious apartness" from the other structural remains (Smith 1952). Difficulty in distinguishing kivas from domicillary pit structures prior to ca. A.D. 950-1000 is also encountered in the Kayenta Anasazi region, so the paucity of evidence for these structures in earlier Virgin Anasazi contexts is not too surprising. Despite claims to the contrary, however (e.g., Rafferty and Blair 1984), no convincing examples of late Pueblo I or Pueblo II kivas have been excavated west of Zion Park or in the Lost City region. This distributional evidence suggests that kiva architecture and the associated ceremonial complex did not extend into the western Virgin area. The implications of this pattern are discussed in greater detail below.

Pueblo II Settlement-Subsistence Strategies. The data currently available from the Arizona Strip suggest that several alternative settlement-subsistence strategies were implemented during the Pueblo II period. Some of these strategies are believed to have involved seasonal mobility, although permanent occupation of certain optimal localities along the lower and middle reaches of the Virgin River and along the base of the Vermillion Cliffs near Pipe Springs may have occurred as well.

Schwartz et al. (1980, 1981) proposed a biseasonal settlement model for the eastern Grand Canyon region, specifically the Walhalla Plateau and Unkar Delta. According to this model, the inhabitants of these areas constituted a single population that moved between winter-spring settlements on Unkar Delta to summer-fall farmsteads on the Walhalla Plateau. The idea of a single population occupying both areas is supported by heavy mineral ceramic analyses that demonstrate the existence of a single ceramic assemblage common to both areas (Balsom 1984). The extensive trail system linking the primary population centers in both areas offers additional circumstantial support for a single interacting population (Euler and Chandler 1978).

Seasonal movement between the inner canyon and plateau is supported by architectural data. The infrequent occurrence of hearths at the Walhalla Plateau sites and their association with an extensive system of check dams, terraces, and waffle gardens implies a summer occupation of the uplands. Kivas are present at Unkar Delta but are absent on the Walhalla Plateau. Based on analogy with ethnographic Hopi data, this distributional pattern supports the winter lowland occupation hypothesis. Furthermore, as Schwartz et al. (1981) and Euler (1979) point out, it seems highly unlikely that any population would choose to live at 8,000+ ft. elevation where winter snowfalls currently average 150 in., when a well-watered, warm lowland area with an abundant driftwood fuel supply was located less than a days' walking distance away. Agricultural features are also present at Unkar Delta, suggesting that a double-cropping strategy may have been followed (early spring planting in the lowlands, late spring planting in the uplands).

Survey data from Powell Plateau suggest that in this area an alternate seasonal settlement strategy involving movement between small summer field houses and multiroom winter pueblos took place within the confines of a single environmental zone (Effland et al. 1981:43). This interpretation is based on quantified differences in room size and other variables indicative of seasonal occupancy. Powell's (1983) ethnographic analysis of seasonally occupied sites showed that winter habitations were significantly larger and contained more storage space than summer occupied sites. Seven of the 79 structural sites recorded on the Powell Plateau had 10 or more rooms, while 2.2 rooms were the average number per site. Approximately 75 percent of the rooms at these larger sites were interpreted as storage facilities based on width measurements of less than 2.0 m. Contemporaneous small sites generally consisted of one to two rooms ranging between 2.5 and 3.0 m in width. Average room size at the large pueblos (those with 7+ rooms) was significantly higher than that of the small sites, even though the small sites lacked storage facilities (Effland et al. 1981:24-33).

In addition, Effland et al. (1981:29) noted that some multiroom pueblos on the Powell Plateau exhibited a single exceptionally large room, which they interpreted as serving a social intergrative function similar to kivas (1981:43). The interpretation of these rooms as kivas is questionable. Excavation data from other areas of the Virgin Anasazi region (e.g., Dalley and McFadden 1985; Smith 1940; Aikens 1965) suggest a multi-purpose habitation function to be more plausible. The presence or absence of kivas, however, does not preclude the interpretation of the multiroom pueblos as winter habitations. The lower elevation and more moderate climatic regime of the Powell Plateau, relative to the North Rim, would have permitted year-round occupation of this area. Dispersed summer habitations would have maximized the horticultural potential of the plateau, since arable areas are scattered and spatially limited.

The Powell Plateau settlement model may be applicable to other areas of the Arizona Strip, particularly the Kanab Plateau- Mount Trumbull region (Westfall 1987b:182-183) and the Paria Plateau. In both these areas, the majority of Pueblo II sites are small one- to four-room structures, but larger, apparently contemporaneous C-shaped pueblos with more than a dozen rooms also occur. Ceramics from these sites indicate that both site types were occupied primarily during the middle to late Pueblo II period (Moffitt and Chang 1978; Mueller 1972; Westfall 1987b; see also the discussion of Mount Trumbull site distributions in Chaper 9, this volume). Of course, the coexistence of large and small sites can be explained in terms of other models that do not involve seasonal mobility. For example, Larson (1983) suggests that during the period from ca. A.D. 700 to 1150, Virgin Anasazi sociopolitical organization resembled a "tribal" or "Big Man" society, as Lightfoot and Feinman (1982) have postulated for other areas of the northern Southwest. Following the theoretical arguments set forth by Lightfoot and Feinman (1982), Larson argues that the larger sites may have functioned as ceremonial and redistributive centers, which served to intergrate the surrounding population into a regionwide sociopolitical organization. Rafferty and Blair (1984:74) take Larson's arguments even further and suggests that the Virgin Anasazi were organized in a chiefdom or ranked society (Peebles and Kus 1977). The applicability of these sociopolitical models for interpreting the Virgin Anasazi settlement behavior is debatable (e.g., Johnson n.d.). Nevertheless, Larson's (1987) and Rafferty and Blair's (1984) use of such models highlights the importance of considering social organizational factors in future interpretations of settlement pattern data from the Arizona Strip.

In addition to social factors, temporal constraints may be partly responsible for the apparent diversity in Pueblo II settlement strategies. For example, on the Powell Plateau, Effland et al. (1981:37) noted that seasonally used rooms are most commonly associated with Sosi Black-on-white ceramics (69 percent). Although the proportions of habitation and storage rooms are similar for sites exhibiting Sosi and Flagstaff Black-on-white ceramics, there is a significantly lower ratio of seasonally occupied and habitation rooms associated with Flagstaff Black-on-white ceramics. Effland et al. (1981:37) suggest that this pattern may reflect decreased use of seasonally occupied sites during the last phase of occupation. An alternative explanation would have the Anasazi occupying seasonal sites off the Powell Plateau during this later time period. In any case, it would seem that the co-existence of large and small sites within the confines of the plateau was primarily an early and middle Pueblo II phenomenon, and that during the late Pueblo II and early Pueblo III periods, a multiple cropping, upland-lowland strategy became more prevalent.

In support of this hypothesis, the ceramic assemblages collected by Schwartz (1960) from Shinumo Canyon, immediately below the Powell Plateau, indicate primary use of this area post dating A.D. 1100. Similarly, use of Unkar Delta appears to have been primarily confined to the late Pueblo II-early Pueblo III period. Although Schwartz et al. (1980) and others (e.g., Euler and Chandler 1978; Effland et al. 1981) have consistently placed the occupation of the inner canyon deltas between A.D. 1050 and 1150, revisions in the dating of ceramic types from the Kayenta region (Ambler 1985; Dean 1982) suggest somewhat later starting and ending dates. According to Schwartz's ceramic data, most of the occupation on Unkar Delta occurred during the Zoroaster (A.D. 1075-1100) and Dox (1100-1150) phases (the earlier Vishnu phase, A.D. 1050-1070, was defined on the basis of a single site). The key diagnostics for the Zoroaster phase include Sosi and Dogoszhi Black-on-white, Tusayan Black-on-red, and Citadel and Cameron Polychrome ceramics, while the Dox phase is marked by the appearance of Flagstaff Black-on-white and small amounts of Tusayan Polychrome. Ambler's (1985:51) analysis of securely dated single component ceramic assemblages from the northern Kayenta region indicates that sites exhibiting high frequencies of Sosi and Dogoszhi Black-on-white and Tusayan Black-on-red with minor percentages of Medicine Black-on-red, Black Mesa Black-on-white, and polychromes date around A.D. 1100, while sites with Flagstaff Black-on-white and Tusayan Polychrome post-date A.D. 1150. In combination, the ceramic data from Unkar Delta suggest an occupation spanning a period from about A.D. 1075 to 1200. If so, the summer upland-winter lowland strategy postulated by Schwartz and others is primarily a late Pueblo II development that continued into the following early Pueblo III period.

One question that naturally arises concerning the extensive use of upland environments during Pueblo II is why this pattern was apparently restricted to the post-A.D. 1050 period. Two factors commonly cited to account for this settlement shift include climate change and the introduction of new crops. Evidence for a period of increased moisture and warmer temperatures across the central Colorado Plateau between ca. A.D. 1050 and 1150 is fairly well established (Dean et al. 1985; Euler et al. 1979; Petersen 1983; but see also Lindsay 1986:472). Although the widely cited climatic model developed by Dean et al. (1985) does not incorporate evidence specifically derived from the Arizona Strip, their climatic reconstruction is generally believed to be applicable to the entire Four Corners region (see Chapter 2, this volume). The introduction of new strains of maize specifically adapted to more arid conditions with shorter growing seasons has frequently been suggested as a catalyst for the Pueblo II expansion (e.g., Martin and Plog 1973). Prior to ca. A.D. 700, a Chapalote-type of maize was grown on the southern Colorado Plateau. During Pueblo I, an eight-rowed variety, Horinoso de Ocho, is believed to have been brought into the Southwest. Crossbreeding with local varieties resulted in a heartier strain that was better adapted to the agriculturally marginal upland environments (Martin and Plog 1973:277). Although a salubrious climate and the introduction of new strains of corn adapted to dry farming may account for Pueblo II expansion in the uplands, they do not explain the simultaneous expansion into lowland canyon environments.

Perhaps the incorporation of cotton into the Anasazi horticultural system accounts for the canyon bottom occupation, since cotton grows best in relatively hot, well-watered areas with long growing seasons. In addition to providing a catalyst for the colonization of previously underutilized areas such as the inner Grand and Glen canyons, the introduction of cotton may have contributed to the development of a seasonally mobile settlement strategy, because cotton cultivation would have necessitated continued use of lowland environments, even after improved climatic conditions permitted dry farming in previously unproductive environments such as the Walhalla Plateau. The timing of the introduction of cotton cultivation on the Colorado Plateau is crucial for interpreting the role of this commodity in the development of Virgin and Kayenta Anasazi socioeconomic systems. In the Glen Canyon region, cottonseed and bolls indicative of local cultivation appear sometime during the Pueblo II period (Cutler 1966). Dating of cotton from the Virgin area has not yet been attempted, although a Pueblo II date is generally assumed. Cotton bolls have been recovered from a Pueblo II granary (UN 46) at Unkar Delta (Cutler and Blake 1980:211), indicating that the cultivation of cotton occurred in the eastern Grand Canyon during this period. Kent (1983:28) suggests an A.D. 1100 date for the beginning of cotton cultivation on the Colorado Plateau, while Hall and Dennis (1986:111) propose a post-A.D. 1100 introduction date. Once introduced, cotton cultivation undoubtedly played an important role in the western Anasazi economy. The implications of this development for interpreting other aspects of Virgin Anasazi prehistory are discussed in greater detail below.

Pueblo II Regional Interaction and Exchange. The initiation of cotton cultivation in the canyon lowlands bounding the southeastern margin of Arizona Strip during the late A.D. 1000s may be tied to other cultural phenomena noted for this period. As mentioned previously, there is a marked increase in the occurrence of Kayenta Anasazi trade wares on the Arizona Strip after ca. A.D. 1050, and Kayenta style kivas make their first appearance around this time. This influx of Kayentan traits has been interpreted as evidence for a Pueblo II migration of Kayenta Anasazi into the eastern Arizona Strip (Hall 1942; Effland et al. 1981). This hypothesis, although never subjected to rigorous testing, has gained considerable acceptance in recent years (e.g., Effland et al. 1981; Plog 1979). The context in which this hypothesized expansion occurred has never been elucidated. It is suggested here that the apparently abrupt appearance of cotton cultivation among the Anasazi during late Pueblo II was at least partly responsible for the demographic expansion and, moreover, was probably linked to the concurrent development of a pan-Southwestern trade network that extended well beyond the boundaries of the Colorado Plateau.

Following the introduction of this valued commodity, Kayenta Anasazi farmers moved into lowland environments and the immediately adjacent uplands bounding the eastern and southern margins of the Strip, thereby bringing them into direct contact with the Virgin Anasazi occupants of the area. A number of Southwestern archaeologists (e.g., Dean et al. 1985; Gumerman 1975; Martin and Plog 1973; Lightfoot 1978) have suggested that the development and maintenance of intra- and interregional exchange networks served as a buffering mechanism that enabled people to subsist in an unpredictable environment. Effland et al. (1981:46) argue that the Powell Plateau (and by extension, other localities on the Arizona Strip) was always marginal for horticulture, and hence, intergrative mechanisms, including inter- and intraregional exchange, were necessary to ensure the survival of the population during periods of local subsistence shortages. They follow Dalton (1977) in suggesting that exchange networks were maintained through regular trading of highly valued commodities such as decorated ceramics, exotic lithic materials, shell, turquoise, and paints (Effland et al. 1981:46).

It would seem that cotton should also be included on this list. If cotton was the primary item of exchange, however, this might explain the anomalous lack of evidence for reciprocal exchange between the two regions (Aikens 1966:54). The prehistoric exchange of cotton is difficult to evaluate, since it is not readily traceable to a specific locality. Other exchanged items such as turquoise and obsidian are more readily evaluated in this respect and have the potential to greatly improve our knowledge of Pueblo II exchange networks. Preliminary trace element analyses of obsidian from the Arizona Strip indicate that both Utah (Modena) and northern Arizona (Government Mountain and Partridge Creek) obsidians were imported to the Arizona Strip during the Formative period (Lesko 1987; Rick Malcolmsom, personal communication 1987). Although temporal distribution patterns are not well established, preliminary studies suggest that the northern Arizona obsidians occur more often in Pueblo II contexts and are largely confined to the eastern Strip (Lawrence Lesko, personal communication 1988). If this pattern holds up under further scrutiny, this would provide additional evidence concerning the economic orientation of Anasazi populations on the eastern Strip and would lend support to the hypothesis of an Kayentan intrusion during the Pueblo II period. It could also provide important information relating to the nature of Virgin Kayentan interaction during this period. Clearly, this avenue of research holds considerable promise.

The temporal and geographic distribution of olivine temper from the Mount Trumbull area offers another fruitful avenue of research. Studies of ceramic assemblages from the Lost City area (Acker 1983; Larson and Olson 1984; Lyneis 1986b; Olson 1979) indicate that there are marked changes through time in the distribution of this widely used temper type. Lyneis (1986b) notes that olivine temper increases to highs in excess of 30 percent during the early middle Pueblo II period, then declines to less than 5 percent. Similar studies from localties on the Arizona Strip are needed to establish whether this a regionwide pattern, or whether it reflects a localized phenomenon, and to interpret this pattern in terms of shifting demographic patterns and the reorientation of exchange relationships through time. The nature of Virgin Anasazi interaction with Great Basin populations during the Pueblo II period has been treated in a couple of recent studies (Lyneis 1984a; Rafferty and Blair 1984). Lyneis (1984a:88) suggests that during the Pueblo II period, the Lost City settlements may have functioned as a gateway community (Hirth 1978) on the western Anasazi frontier, funneling trade items such as shell from the Gulf of California and turquoise from the Great Basin region to the Colorado Plateau. The mechanisms by which these commodities filtered to the more easterly Anasazi communities on the Arizona Strip and across the Colorado River are still uncertain. Preliminary studies of the distribution of exotic trade items (Lyneis 1984a) suggest that there was directional trade from the coast of California to the Lost City area, but that down-the-line exchange (Renfrew 1977) through a dendritic distribution network characterized exchange systems east of the Virgin Anasazi frontier. Nevertheless, Lyneis (1984a:88) acknowledges that data supporting this position are inconclusive.

Pueblo III Period,ca.A.D.1150-1200/1225

The archaeological literature indicates a lack of consensus concerning the nature and extent of Anasazi occupation on the Arizona Strip after A.D. 1150. Many investigators maintain that the region was abandoned by A.D. 1150 (Aikens 1966; Effland et al. 1981; Euler and Chandler 1978; Euler et al. 1979; Schwartz et al. 1980, 1981; and others). Although it is true that sites dating to this period are uncommon on the Arizona Strip, a few sites with early Pueblo III pottery types such as Flagstaff Black-on-white and Tusayan Polychrome are known to occur on the tributary deltas in the eastern Grand Canyon (Jones 1986b; Schwartz et al. 1980; Schwartz et. al. 1981), on the Paria Plateau (Haskell 1978; Mueller et al. 1968), in the vicinity of the Cockscomb (Judd 1926), and along the northern flanks of Saddle Mountain (USFS site files). In eastern Grand Canyon, Jones (1986b) obtained two late dates A.D.1360 ± 140 and A.D.1250 ± 90 from a multicomponent habitation site (AZ:C:13:10 [GRCA]) with an early Pueblo III ceramic component. Although somewhat late, these radiocarbon determinations generally support the A.D. 1150 to 1220 occupation dates suggested by the presence of Flagstaff Black-on-white and Tusayan Polychrome sherds. Jones (1986b:110) places the abandonment of the site at around A.D. 1200.

Further evidence for an abandonment date in the early thirteenth century comes from sites on the Kanab Plateau and at Quail Creek (Thompson and Thompson 1974; Walling et al. 1986; Westfall 1987b). Radiocarbon determinations from these excavated sites range from the late A.D. 1100s to early 1500s. At GC-671 in the Tuweep area, the Thompsons obtained a suite of four dates ranging from A.D. 1110 ± 110 to A.D. 1320 ± 100. This site had been specifically selected for excavation because the ceramics indicated it to be a single component occupation dating to the latest period of Anasazi occupation in the area, and it was hoped that dates from the site would shed some light on the dating of the Anasazi abandonment of the region. Although the ceramics suggested an occupation during late Pueblo II, Thompson and Thompson (1974:20) were inclined to accept the overlapping dates as evidence of an occupation terminating around A.D. 1250. More recently, Westfall (1987b) reported a series of thirteenth and fourteenth century radiocarbon dates from the Pinenut site. Once again, the ceramic assemblage indicated a predominantly Pueblo II occupation date, but a tight cluster of five dates ranging from A.D. 1235 ± 55 to A.D. 1360 ± 85, from five separate proveniences at the site, argued fro the presence of a Pueblo III component dating about A.D. 1200 and 1250 or 1275 (Westfall 1987b:90).

Diagnostic Pueblo III Artifacts. The principal diagnostics for this period include the Kayenta trade wares, Flagstaff Black-on-white and Tusayan Polychrome. These types usually co-occur with Sosi and Dogoszhi Black-on-white, Tusayan and Moenkopi Corrugated, and their Virgin analogs, North Creek Black-on-gray, Virgin Black-on-white, North Creek Corrugated, Shinarump Walhalla Corrugated, and

Washington Corrugated ceramics. Thompson (in Walling et al. 1986:352) has recently subdivided and renamed North Creek Black-on-gray and Moapa Black-on-gray according to design styles. The Flagstaff analogs are called Glendale Black-on-gray and Poverty Mountain Black-on-gray respectively. Breternitz (1966) placed the beginning date for Flagstaff Black-on-white at ca. A.D. 1100, but Dean's (1982) more recent analysis of tree-ring data indicates that the type was not manufactured prior to A.D. 1150. Ambler's (1985) independent assessment of dendrochronologically dated single component ceramic collections from the northern Kayenta region supports an initial manufacturing date for Flagstaff Black-on-white in the late 1100s. The Tsegi Orange Ware types, Cameron and Citadel polychromes, make their initial appearance in the Kayenta region at around A.D. 1100 (Ambler 1985). Nankoweap Polychrome, the San Juan Red ware analog of Citadel Polychrome, occurs most frequently in the eastern sector of the Strip, although it is never common. Tusayan Polychrome is a slightly later version of these types characterized by the presence of an exterior-banded red slip, as opposed to the overall exterior red slip employed on the early polychromes. This minor variation in the application of the exterior slip appears to be temporally diagnostic of the P III period in general.

Pueblo III Settlement-Subsistence Systems. Knowledge of early Pueblo III settlement subsistence systems is currently very limited. Schwartz's data from Unkar Delta suggest that during the Dox phase, settlements shifted from the river terraces to talus slope and dune locations. These locational adjustments have been interpreted as evidence that arable land was in shorter supply during this period relative to the preceding period (Effland et al. 1981:44). Because settlement data indicate that the population size was roughly comparable to that of the preceding phase (Schwartz et al. 1980:186), reduction of the area's carrying capacity is assumed to have occurred. Climate change accompanied by widespread erosion is considered to have been the main factor responsible for settlement shifts during this period (Dean et al. 1985; Schwartz et al. 1980).

The ceramic evidence from sites associated with agricultural features on the Walhalla, Powell, and Kanab plateaus suggests that horticultural intensification practices developed in the late 1000s or early 1100s. The timing of this development is crucial for interpreting the last phase of Anasazi occupation on the Arizona Strip. If horticultural intensification techniques were in use by A.D. 1050, factors other than climate change may have been responsible for their initial development, because several independent lines of evidence indicate that the mid-eleventh century was generally favorable for horticulture (Chapter 2, this volume; see also Dean et al. 1985). Over-extension of the region's carrying capacity due to population growth could be an alternative explanation for the development of horticultural intensification features during Pueblo II, but current data are not sufficient to support this hypothesis. On the other hand, if agricultural features became widespread during the mid-1100s, then deterioration in climate would seem more likely to be the cause of agricultural intensification. The temporal distribution of agricultural features in northern Arizona provides a proxy measure of the development and spread of horticultural intensification technologies. There is a notable lack of evidence for the presence of agricultural features in the northern Kayenta Anasazi region prior to the mid-A.D. 1200s (Geib et al. 1985). In the Glen Canyon, check dam and irrigation systems (Lindsay 1961; Sharrock et al. 1963) are dated to the late A.D. 1100s on the basis of associated ceramics (Lipe and Lindsay 1983). Similar dates are indicated for the check dam and terrace systems around Tusayan Ruin on the south rim of Grand Canyon (Janet R. Balsom, personal communication, 1987). Slightly earlier dates are indicated in the Wupatki region (Bruce Anderson, personal communication, 1987), while in the Cohonina region, check dams and terraced gardens appeared sometime during the Pueblo II period (Thomas Cartledge, personal communication 1987).

This distributional evidence suggests that horticultural intensification techniques first developed in northwestern Arizona north and south of the Colorado River sometime after A.D. 1000 and eventually spread eastward. The explanation for this distributional pattern remains elusive; differences in the amount of rainfall between the northwest and northeastern portions of Arizona may account for the earlier development of these features in the west, but other factors such as population growth or the cumulative effects of inefficient farming techniques resulting in widespread erosion, might also have precipitated these developments. Climatic reconstructions specific to the Arizona Strip and Coconino Plateau are obvious prerequisites for resolving this important research issue.

Termination of the Formative Anasazi Occupation

The demise of the Virgin Anasazi culture on the Arizona Strip is commonly attributed to one of two causal agents: prolonged drought (Schwartz et. al. 1981; Euler and Chandler 1978; Euler et al. 1979) or Numic population expansion (Euler 1964; Madsen 1975; Schroeder 1961; Steward 1933). As discussed above, data pertaining to the climatic patterns of this time period on the Arizona Strip are in short supply, and the role of climate change in bringing about the end of Anasazi occupation on the Arizona Strip remains highly speculative. Nevertheless, most reconstructions rely on climatic factors to one degree or another to explain the demise of the Virgin Anasazi culture. With regard to the Numic expansion, aggression and resource competition have been the most frequently suggested factors influencing the Anasazi abandonment of the Arizona Strip.

Although the Numic aggression hypothesis has emerged in various forms over the years (e.g., Euler 1964:380; Schroeder 1961:113; Steward 1933:20; Ambler and Sutton 1986), it has never gained wide acceptance. This is largely a reflection of the lack of data to support (or refute) the argument. Historical records depicting the Southern Paiute as timid, retiring people prone to flee in the face of danger (e.g., Bolton 1950) are sometimes cited as evidence against the Paiute aggression hypothesis. This behavior pattern, however, may have been a response to relentless slave raiding by Utes and Northern Paiutes (Malouf and Malouf 1945) during protohistoric and historic times. Indeed, given that the primary aggressors against the Southern Paiute during historic times were other Numic speaking peoples, one could argue that aggressive behavior was actually well developed among Numic peoples (Sutton 1987:175-178). Furthermore, there are occasional references to Southern Paiute aggression in the oral traditions of neighboring historic tribes (e.g. Spier 1928). One Southern Paiute legend (Heizer 1954:3) implies that Paiutes were directly responsible for driving the Anasazi out of the region and across the Colorado River. Although it is possible that this legend is an accurate recital of thirteenth century events, it also could be a reflection of the ambivalent relationship that existed historically between the Hopi and Southern Paiute. During the historic period, the relationship between the Hopi and Southern Paiute was characterized by periods of hostility interspersed with peaceful exchanges. This sort of ambivalence characterized historic forager-farmer interactions throughout the Southwest, as well as in many other parts of the world. In any case, archaeological evidence to support or refute the Numic aggression hypothesis is sorely lacking, and may never be found.

Changes in prevailing socioeconomic and environmental conditions, rather than Numic aggression, is the most commonly suggested explanation for the Anasazi abandonment of the Arizona Strip. Euler, a former proponent of the Numic aggression hypothesis (Euler 1964:380) is now of the opinion that the Anasazi abandonment was largely a response to adverse climatic conditions. Euler et al. (1979; Dean et al. 1985) postulate that a mid-twelfth century drought forced large scale settlement shifts over broad areas of the Colorado Plateaus, which led to a disruption of exchange networks and subsequent systemic collapse. Only in those areas most favorable to horticulture were the Anasazi able to maintain or re-establish their cultural system in a somewhat modified form. Euler sees no causal relationship between the Anasazi abandonment and later Paiute occupation of the Strip. He maintains that abandonment occurred by A.D.1150, followed by a 150-year-long occupational hiatus. An entry date for the Southern Paiutes around A.D. 1300 is postulated (Robert C. Euler, personal communication 1986).

The recent testing of two stratified midden sites in the western Grand Canyon (Jones 1986b) offers tentative support for Euler's position. At the Tuna Creek site, AZ B:15:7 (ASM), a 20 to 50-cm-thick band of sterile, waterlaid sediment separated a lower stratum containing Virgin Anasazi ceramics from an overlaying stratum with Paiute brownware and Jeddito Black-on- yellow ceramics. Although sedimentological analyses indicated that the sterile band could have been deposited by a single flash flood episode (Karlstrom 1986:30), the lack of overlap in the artifactual materials from the two cultural strata suggested that there had been a significant hiatus between the two occupations. Unfortunately, the radiocarbon dates from the upper and lower levels were inconclusive regarding the duration of this hiatus (Jones 1986b:106). At AZ:A:16:1 near Whitmore Wash, Paiute ceramics and sandals overlay strata containing Moapa Gray ware. A charcoal sample from a roasting pit in the Paiute level produced an uncorrected date of A.D. 1245 $\pm$ 75; regrettably, comparative dating of the Virgin Anasazi levels was not attempted. Nevertheless, a distinct break in the stratigraphy was readily discernible between the Virgin and Paiute levels. Although the data recovered from these two sites are equivocal in many respects, the stratigraphic separation of the Paiute and Virgin materials, in conjunction with the late thirteenth and fourteenth century dates from the Paiute levels at both sites, lend support to Euler's argument that an occupational hiatus during the 1200s preceded the Paiute entry in the Grand Canyon region.

In contrast to Euler's position, Madsen (1975:84) argues that interactions occurred between Southern Paiutes and neighboring Fremont and Anasazi groups on the eastern edge of the Great Basin as early as A.D. 1000. He bases his position on the association of Fremont, Anasazi, and Southern Paiute ceramics at several rockshelter sites in southeastern Nevada (Fowler et al. 1973; Shutler et al. 1960) and western Utah (Aikens 1970; Rudy 1954). Madsen (1975) hypothesized that the Numics were able to expand into Sevier Fremont territory after A.D. 1200 because their hunting-gathering adaptation offered a competitive advantage over the mixed horticultural foraging strategy of the Sevier Fremont during periods of environmental stress. Madsen maintained that when environmental factors made farming untenable, the Fremont were forced to compete directly with the Numics for the same limited resources. Because their subsistence system was poorly adapted for year-round hunting and gathering, the Fremont were less successful in extracting wild resources and the Numics were able to expand at their expense. Madsen did not believe that this argument was applicable to the neighboring Virgin Anasazi, however, because the prevailing concept was that the Anasazi were not as dependent on wild foods as the Sevier Fremont. The Anasazi, therefore, would not have been placed in direct competition with Numic hunter-gatherers for the same limited resources.

Madsen's assumption is probably incorrect. The large numbers of Virgin Anasazi food procurement/processing stations and base camp sites on the Arizona Strip (Moffitt et al. 1978; Teague and McClellan 1978; Davis and Westfall 1982; Lipe and Thompson 1979), in conjunction with fecal and macrofossil evidence (Fry 1970; Stiger 1981; Heath 1986; Scott 1981, 1985, 1987; Van Ness 1987) indicate that wild resources formed an important component in the Anasazi diet . Although the degree of Virgin Anasazi dependence on wild foods remains uncertain, it is probably safe to assume that noncultivated resources contributed a substantial portion to the yearly subsistence base, particularly in the spring and early summer when food stores would have been depleted. Thus, Madsen's arguments regarding Numic Fremont competition may also be valid for Virgin Anasazi.

A model that attempts to explicate the competitive advantage of the Numic subsistence strategy in relation to pre-existing hunting-gathering systems has recently been developed by Bettinger and Baumhoff (1982). Bettinger and Baumhoff's fundamental argument revolves around the premise that prehistoric hunter-gatherers had a range of adaptive strategies to choose from, and that during periods of environmental change, the advantages inherent in particular adaptive systems allowed certain hunter-gatherer groups to outcompete and displace pre- existing groups. This dynamic promoted the spread of ethnic groups. Bettinger and Baumhoff suggest that pre-Numic subsistence strategies were specifically oriented towards the exploitation of a few key resources. In contrast, the Numic system was adapted for the intensive exploitation of a diverse resource base, including many low value, high cost food sources such as small seeds and insects. They characterize these two strategies in terms of "collectors" and "processors." Pre-Numic "collectors" could maintain a competitive edge over Numic "processors" during times of resource abundance because their subsistence system was geared to the efficient exploitation of high value resources (e.g., large game, pinyon nuts). During periods of resource shortage, however, the high value resources would be rapidly depleted, leading to direct competition between the "collectors" and the Numic "processors" for the relatively abundant, low value-high cost resources. Because the Numic subsistence system was pre-adapted for the exploitation of this resource base, the Numic "processors" were able to out compete the "collectors". Thus, during periods of environmental stress, the Numic were able to expand at the expense of neighboring groups.

Although the Bettinger-Baumhoff model was primarily designed to account for the Numic expansion within the Great Basin, it may also provide a model for interpreting the prehistoric relationship between Numic hunter-gatherers and the semi-sedentary Virgin Anasazi. Essentially, the Virgin Anasazi adaptation could be construed as a collector strategy focused on the exploitation of a few key (mostly cultivated) resources. During periods of resource abundance, competition between the two groups would have been minimal. Exchange of food resources would have served to mitigate the effects of localized resource imbalances and scheduling conflicts (Sahlins 1972; Effland et al. 1981). A symbiotic relationship involving the exchange of wild and cultivated food resources could have developed at this time. Such exchanges probably took place in the autumn, following the harvest, when highly valued resources such as pinyon nuts, deer, and corn, were most abundant. The common occurrence of mixed Southern Paiute Virgin Anasazi ceramic assemblages at campsites in the pinyon-juniper zone on the Shivwits Plateau (Teague and McClellan 1978), in the Beaver Dam Mountains (Moffitt et al. 1978), and in other areas adjoining the Arizona Strip (Fowler and Sharrock 1973; Rafferty and Blair 1984; Rudy 1953) could be a reflection of these autumn trading ventures.

During periods of resource shortages, however, the Anasazi and Paiutes would have been placed in direct competition with each other for some of the same essential resources. The symbiosis developed during the preceding optimal period would have accentuated this competition as each group sought access to the other's valued resource base. In this situation, the mobile Numic bands would have had a decided advantage over the Anasazi, both in terms of raiding and wild resource procurement abilities. The prevalent Pueblo II settlement pattern of scattered Anasazi farmsteads would have provided an easy target for Numic raiders, but the reverse situation did not obtain for the Anasazi. In fact, the Anasazi would have been placed in the uncomfortable position of having to choose between leaving their farms undefended to go in search of wild food resources, thereby risking the possibility of a raid in their absence, or staying home and facing the possibility of starvation. They had other options of course, including agglomeration in defensible locations and migration. Agglomeration would have necessitated major restructuring of the Virgin Anasazi social system, while migration offered the possibility of re-establishing the former lifeway in a slightly different setting with a minimum of change. Given this choice, migration probably would have been the preferred option for the upland farmers.

In some portions of the Strip, however, agglomeration in defensive locations may have been the preferred strategy. Along the Virgin River, a settlement pattern involving relatively large clusters of habitations situated on hilltops was already well established by Pueblo II times (Jenkins 1981). When faced with the same set of options, the Virgin River populations may have initially opted for a defensive strategy, since this would require the least amount of adjustment to their existing way of life. The wide-spread displacement of upland populations would have disrupted established exchange and communication networks, however, leaving this segment of Anasazi society isolated from the main Anasazi population centers to the east. Without the region-wide infrastructure to support it, the foundations of this isolated community would eventually have crumbled, precipitating a major reorganization of the existing sociocultural system or systemic collapse.

Most archaeologists are of the opinion that the Virgin Anasazi abandoned the region, either voluntarily or by force, and were eventually replaced by a distinct group of Numic speaking hunter gatherers from the Great Basin. Gunnerson (1962, 1969) is one of the few to support an alternative interpretation. Gunnerson argues that the Virgin Anasazi never abandoned the Strip region; instead, they underwent a cultural transformation and evolved into the ancestral Northern Paiute. Based in part on linguistic evidence compiled by Hale (1958:107) and Lamb (1958), he argues that Virgin Anasazi were proto-Plateau Shoshoneans, that the Sevier Fremont and San Rafael Fremont developed as northern extensions of the Virgin Anasazi, and that these three archaeological manifestations represent the ancestors of the historic Shoshonean speakers of the Colorado Plateau. Gunnerson suggests that adverse climate changes forced the Anasazi and Fremont to abandon horticulture and revert to the hunting and gathering subsistence strategy of their forebearers, thereby resulting in a total cultural transformation. The mechanisms involved in this transformational process were never explicated. Gunnerson's basic premise--that the Virgin Anasazi gave up farming, reverted to hunting and gathering, and are directly ancestral to the historic Paiutes has received some cautious consideration (e.g., Moffitt et al. 1978) and limited support (Thompson et al. 1983:132). Most archaeologists, however, find the argument untenable. Current linguistic and archaeological evidence (Fowler 1972; Fowler et al. 1973; Lamb 1958; Madsen 1975; Miller 1966) overwhelmingly support the existence of a distinct Numic-speaking population with a characteristic material culture in the southeastern Great Basin by A.D. 1000, and at least one recent study (Goss 1977) suggests that this population was in place many centuries prior to that date. It seems highly improbable that the Virgin Anasazi would maintain a distinct cultural system for two centuries or more while simultaneously interacting with the Southern Paiute, only to abandon their identity and convert to a new ethnic identity in the face of environmental stress.

If the Virgin Anasazi did not turn into Paiutes, then what became of them? Euler (personal communication 1986) believes that the Anasazi occupants of the eastern Grand Canyon region moved across the Colorado River, back to their ancestral homeland. The presence of several moderately large early Pueblo III sites in the Coconino Basin (Rice et al. 1980) and along the southeastern rim of Grand Canyon (Haury n.d.; Janet Balsom, personal communication 1984) may be indicative of a gradual withdrawal to the southeast at this time.

Euler does not attempt to account for the fate of the entire Virgin Anasazi population, only a small segment of it. The fate of the remaining Anasazi is left to speculation. Conceivably, the Anasazi could have dispersed in several directions simultaneously: some moving in with Fremont neighbors to the north, others taking up residence in the Kayenta region to the east, and some possibly merging with the neighboring Pai and Paiutes to the south and west. There is little concrete evidence to support this gradual diffusion model.

A sharp population increase on Cummings Mesa during the early A.D. 1200s and subsequent population growth in the vicinity of Navajo Mountain during the middle 1200s has been attributed in part to migrations from the western Anasazi region (Ambler et al. 1983). The source of the emigrant population remains disputable, but the Paria Plateau would seem to be one logical candidate. The evidence for a population influx to the Navajo Mountain region includes a marked increase in site population beginning about A.D. 1220 (Ambler et al. 1983), the appearance during the mid-1100s of new ceramic types bearing a notable resemblance to the earlier Shinarump/Walhalla and San Juan Red wares from the eastern Grand Canyon area (Callahan and Fairley 1985), and the appearance of specific construction techniques and site layouts in middle to late Pueblo III structures of the northern Kayenta region (Geib and Ambler 1983), some of which have antecedents in the eastern Virgin region. In combination, these various lines of evidence provide tentative support for an actual migration of people into the Navajo Mountain region. This hypothesis, as well as those of Euler, Thompson and others, need to be tested through detailed analyses of architecture, ceramics, and other material culture evidence, as well as through studies of actual human remains (Rouse 1986).

Factors Influencing Formative Settlement Patterns

A number of environmental factors have been suggested to explain the distribution of Anasazi habitation sites within various areas of the Arizona Strip. Some of the recurrent themes include proximity to deep, well-watered alluvial soils and to sources of building stone (Thompson 1971a; Lipe and Thompson 1979). Selection for ecotone transition zones that typically contain the greatest abundance and diversity of floral and faunal resources has also been suggested (Moffitt et al. 1978). There has been disagreement over the relative importance of water sources as a determinant of Formative site location.

Proximity to agricultural land is clearly a primary determinant for habitation site locations during the Formative period. During most of the Formative period, habitation sites tend to be concentrated on low ridges, terraces and knolls overlooking adjacent alluvium. The only apparent exception to this rule occurs with Basketmaker III sites, which are often located along mesa rims, well above the arable valley bottoms. This pattern may be indicative of a Basketmaker III subsistence strategy preferentially oriented towards the exploitation of wild food resources, rather than towards horticulture; however, supporting evidence for this interpretation is currently lacking.

The potential arability of a given area is determined by a variety of factors. A conducive climate with a sufficiently long growing season is clearly prerequisite. Also, adequate precipitation and high water tables in the absence of permanent streams for irrigation is essential. Currently, there is less precipitation on the Shivwits relative to the Kanab Plateau, which limits the horticultural potential of the western alluvial areas (Lipe and Thompson 1979), a fact apparently reflected in the low numbers of farmsteads and fieldhouse sites reported in the area west of the Hurricane Cliffs (BLM site files). Within the Kanab Plateau, the greatest concentration of sites occurs around the alluviated canyon headwaters on the west side of Kanab Creek. In contrast, the perimeters of the extensive sagebrush plains in the Kanab Plateau interior have relatively few sites (Westfall 1987a:43). This distribution suggests that when there is a choice between arable areas, those areas that offer a greater diversity of environmental resources will be selected over homogeneous zones (Westfall 1987a:43).

Although water is obviously an essential requirement for human survival, several researchers have downplayed the importance of water availability as a determining factor in site location on the Arizona Strip (Thompson 1970; Lipe and Thompson 1979). They base this view primarily on the existence of late Formative habitation site concentrations in upland areas where no permanent water sources currently exist. The importance of seasonal water sources, particularly the numerous "pockets" occurring in ephemeral stream bottoms, on rocky outcrops, and along the sandstone benches of the Esplanade, seems to have been underestimated. Given the evidence for warmer and wetter climatic conditions during the eleventh century (Euler et al. 1979), these pockets would probably have contained water for a large part of the year during the Pueblo II period, when the uplands were most intensely occupied. During seasonal droughts, the prehistoric inhabitants of these areas could have obtained water from more distant seeps and springs below the rim of the plateau. The importance of ephemeral water sources to the prehistoric inhabitants of the region is attested to by the concentrations of sites, many of them multicomponent base camps, in proximity to seeps and potholes across the Arizona Strip. This pattern was first noted by John Wesley Powell and his men (Dellenbaugh 1984; Powell 1961) during their 1871-1872 reconnaissance of the Strip and has been supported by subsequent work in the area (e.g., Belshaw and Peplow 1978; Judd 1926:132; Westfall 1987a:33).

As evidence that water was not a critical determinant of site location, Lipe and Thompson (1979) pointed to the apparent paucity of Formative habitation sites on the Shivwits Plateau, where perennial springs are more heavily concentrated relative to the Kanab area. This perspective was based on very limited evidence, however, for at that time (1977), approximately 140 sites had been recorded in the area west of the Hurricane Cliffs. Roughly half of these sites (66) were located along the Virgin River and in Sullivan Canyon; the remainder were concentrated in the southern portion of Shivwits District in and adjacent to Lake Mead National Recreation Area (Baldwin 1978; Schroeder 1961; Shutler 1961; Evans et al. 1969). The higher mountainous areas with abundant springs had not been subject to archaeological investigation. The survey coverage in the Shivwits Resource Area has not greatly increased in the last ten years, so there is little new data exist with which to address this issue. Nevertheless, the fact that the three largest unit pueblos recorded in the Shivwits uplands are all located adjacent to permanent springs reaffirms the idea that water was an important determinant in aboriginal site locational behavior, particularly with respect to habitation sites. Furthermore, if one examines the distribution of site concentrations in relation to currently existing perennial water sources such as along the base of the Vermilion Cliffs, around Mount Trumbull, and along the Virgin River, it is clear that water availability did have a crucial influence on the location of habitation sites throughout the Formative and presumably during earlier and later periods as well.

The availability of natural travel routes between the canyons and uplands was another important factor influencing Formative site distributions. Euler and Chandler (1978) found that site concentrations tended to occur on the points along the North Rim that provided access into the canyon, and that points with no known routes into the canyon were only sparsely occupied, if at all. In addition, they found that sites tended to be distributed along stream bottoms, often the easiest travel corridors through the rugged canyon topography. Inner canyon travel was facilitated by the presence of numerous strategically placed storage caches (e.g., Euler 1971); these features occur most often along natural travel routes linking settlement concentrations in the inner canyon with those on the rim. Euler and Chandler's analysis of Formative site distributions in the Grand Canyon supported their hypothesis that trails were the second most critical resource (next to water) in determining inner canyon site locations. They interpreted this distribution as support for Plog and Hill's (1971:12) proposition that "sites were located so as to minimize the cost of resource and information flow between sites occupied by interacting populations." Site concentrations have been noted in several other areas of the Arizona Strip where drainages and trails provide natural access routes to lower elevation areas, for example, around the headwaters of Snake Gulch (Davis and Westfall 1982), in the vicinity of Jacob Lake on the Kaibab Plateau (Fairley et al. 1984), and on the Paria Plateau around the head of the Sand Crack trail (Mueller 1972). The availability of natural travel corridors was undoubtedly an important variable affecting site distribution during all time periods, not just the Formative (Schroeder 1961; Bradford 1974; Rafferty and Blair 1984).

In locations away from arable land, numerous sites with lithic debitage, projectile points, grinding implements, and Puebloan ceramics attest to the exploitation of wild foods and abiotic resources. Formative period campsites are frequently situated in proximity to natural tanks and along the fringes of upland meadows where deer and other large game animals tend to congregate (Fairley et al. 1984). Groundstone artifacts occur occasionally on Formative period sites on the Kaibab Plateau interior and with greater frequency on sites in the lower elevation pinyon juniper zones (Abbott 1979). The presence of groundstone is a strong indication that plant food procurement and processing activities were commonly carried out in these woodland zones.

Large, crater-shaped features surrounded by masses of burnt rock, commonly termed "mescal pits," are usually interpeted as evidence for agave processing activities. Although roasting pits occur most frequently in the inner canyons, on the Esplanade Bench, and along the base of the Grand Wash Cliffs where agave grows most abundantly, they are not restricted to these areas. Puebloan roasting pit features are also encountered at higher elevations in woodland settings (e.g., Moffitt et al. 1978), an indication perhaps that these features were used to roast corn and other foods, in addition to agave (e.g., Moffitt et al. 1978).

NEO-ARCHAIC PERIOD

Following the terminology proposed by Thompson et al. (1983:131; Walling et al. 1986), the period following the Anasazi abandonment of the Arizona Strip is designated as the Neo-Archaic. Three temporal subdivisions of this period are proposed: Late Prehistoric, Protohistoric, and Historic, The Late Prehistoric period begins after A.D. 1200 and lasts until ca. A.D. 1600, when indirect influences from the Spanish presence in New Mexico presumably first reached the inhabitants of the Arizona Strip. The Protohistoric spans the period between A.D. 1600 and 1776. During this period, the aboriginal inhabitants of the Arizona Strip experienced indirect effects from the European presence in the New Mexican and California colonies, but had yet to be subjected to direct Anglo-Indian contact. The pioneering exploration of the Arizona Strip region by the Spanish friars Dominguez and Escalante during the late autumn of 1776 (Bolton 1950; Warner and Chavez 1976) marks the dividing point between the Protohistoric and Historic periods. Early in the Historic period, limited contacts between Paiutes, Spanish explorers and traders, and Anglo American trappers occurred on a sporadic basis, slave raiding began, and fur trapping became an important impetus for an increasingly strong Anglo-American presence in the region. Until the mid-nineteenth century, however, very little historical documentation is available for the area, hence most of our knowledge about this period must come from archaeological studies. The dividing point between the early and late Historic period is 1850, when military explorers and Mormon settlers arrived on the northern frontiers of Southern Paiute territory. The effects of Anglo expansion on traditional Southern Paiute culture are treated separately in Chapter 5.

Dating of the Southern Numic expansion onto the Colorado Plateau remains speculative. As noted previously, several scholars argue that Southern Numic aggression may have been a significant factor in the late twelfth and thirteenth century abandonments of the Virgin and Kayenta Anasazi regions (Shutler 1961:29, 113; Euler 1964:380; Davis 1964:12; Ambler and Sutton 1986). They point to linguistic evidence that indicates that Southern Numic speakers were drifting eastward out of the Great Basin as early as A.D. 1000 (Lamb 1958) and to archaeological excavations that demonstrate the stratigraphic association of Southern Paiute and Pueblo II Puebloan artifacts (Fowler et al. 1973; Madsen 1975; Rudy 1954; Shutler 1961:29; Shutler et al. 1960). In the Grand Canyon, recent radiocarbon dates recovered from a Paiute midden near the mouth of Whitmore Wash place Southern Paiutes in the area by A.D. 1285 (Jones 1986b). At Tuna Creek, approximately 90 mi upstream, a date of A.D. 1372 was derived from a Paiute midden overlying Anasazi debris (Jones 1986b). Farther to the east, in the central Glen Canyon region, a wickiup within a cave was radiocarbon dated to A.D. 1380 (Agenbroad et al. 1987). Thus, the currently available evidence confirms the presence of Southern Numics in the Arizona Strip by the beginning of the fourteenth century, but the earliest date of their arrival in the area is still in question.

Diagnostic evidence of the Neo-Archaic occupation on the Arizona Strip includes Southern Paiute Brown ware ceramics and Desert Side-notched projectile points. The presence of Jeddito and Awatovi Yellow ware sherds at scattered "campsites" on the Shivwits, Kaibab and Paria Plateaus (Baldwin 1944; Mueller et al. 1968; USFS site files) provides corroborative evidence of a late prehistoric protohistoric Paiute presence on the Arizona Strip (Baldwin 1944; Moffitt et al. 1978). Although temporal assignment of these Hopi trade wares remains somewhat conjectural, dates ranging between ca. A.D. 1325 and 1600 are indicated (Colton 1956). Ongoing studies by Adams et al. (1986) may refine the dating of this type in the near future.

Kelly (1934, 1964), Euler (1966), and Kelly and Fowler (1986) provide comprehensive summaries of early historic Southern Paiute culture. Kelly's ethnographic data were collected in the early 1930s, many decades after the aboriginal hunting and gathering lifeway had been abandoned. Much of her information was based on informants' vague childhood memories or upon stories told to her informants by parents and grandparents. Most of Euler's information came from late eighteenth and nineteenth century historic accounts by trappers, traders and explorers. It is apparent from both Kelly's and Euler's ethnohistoric reconstructions, as well as from more recent studies (Stoffle and Evans 1976), that numerous factors, including Spanish, Navajo, and Ute slave raids, epidemic diseases, and Anglo pioneering efforts caused wholesale displacements and drastic reductions in the Southern Paiute population of southern Utah and the Arizona Strip by the middle 1800s (Stoffle and Evans 1976). After that time, Southern Paiutes were restricted to the harsher, less productive areas of their traditional territories, with consequent readjustments to the traditional subsistence cycle. Because of these historical influences, the applicability of models based on ethnographic and ethnohistoric studies for interpreting the late prehistoric and protohistoric use of the Arizona Strip needs to be independently verified with archaeological data (e.g., Thomas 1973).

Sociopolitical Division of the Southern Paiute

There has been considerable discussion and disagreement among anthropologists concerning the sociopolitical structure of the Great Basin Shoshoneans, including the Southern Paiute (Kelly 1934; Manners 1959; Owen 1965; Service 1962; Steward 1933, 1965, 1970). Most scholars are in agreement with Kelly (1934) that the term "Paiute" had little meaning as tribal designation to the people so named. None of the Numic-speaking peoples conceived of themselves as tribes in the sociopolitical sense of the term, although they recognized a common bond in terms of language. While anthropologists agree that the concept of tribe is not applicable to the Southern Paiute, there is a basic disagreement concerning the validity of the "band" concept as the basic social unit of Southern Paiute society. Steward (1938) argued that family bands comprised the primary sociopolitical and economic units of Southern Paiute society. Owen and Service, on the other hand, argued that the patrilocal band, made up of several related families, was the primary socioeconomic unit of aborginal Shoshonean society, and that the scattered families observed by Steward were merely remnants of a society whose social and political organizations had been disassembled by the effects of European contacts. Manners (1959) sided with Steward's interpretation of the nuclear or extended family group as the highest level of sociopolitical and economic organization in aboriginal society.

Kelly (1934, 1964) felt that the band concept had validity as a social division among the Southern Paiute, although she recognized that families comprised the primary economic units of the society. Kelly (1934) identified fifteen historical Southern Paiute bands based on informants' geographic separation of dialect units. Based on these territorial divisions, Kelly defined Southern Paiute bands as "dialect units with political concomitants" (1934:550).

Although Kelly has been criticized for her failure to delineate the sociopolitical concomitants of these band divisions (Manners 1959), her work has significant ramifications for the study of aboriginal Shoshonean society. An implication of her study is that these dialect divisions developed as a result of frequent interaction among Southern Paiute family units residing within well defined territorial limits and relatively infrequent interaction with Paiutes in neighboring areas. As Kelly (1934:556) aptly pointed out, "the precision with which informants are able to delineate their territory certainly does much to dispel the long standing impression of weak localization which attaches to Great Basin tribes."

Kelly identified five historic Southern Paiute bands whose ranges included or were encompassed by the Arizona Strip: Kaibab, Uinkaret, Shivwits, Moapa, and St. George. According to Kelly, the Kaibab territory extended from Kanab Creek to the Paria River and north from the Colorado River to the Pink Cliffs. The Uinkarets ranged between Kanab Canyon and the Hurricane Cliffs as far north as the Virgin River. Shivwits territory included the area between the Hurricane and Grand Wash Cliffs south from the Virgin Mountains to the Colorado River. The St. George group resided north of the Shivwits around the junction of Santa Clara Creek with the Virgin River, between the Hurricane Cliffs and the west side of the Beaver Dam Mountains. The extreme western margin of the Strip, including most of the Virgin Mountains and the lower Virgin River bottom over to the Muddy River, was claimed by the Moapa band.

Southern Paiute Settlement and Subsistence Systems

Kelly documented the Kaibab Paiute pattern of seasonal mobility in considerable detail, noting the locations of base camps, important water sources, favored areas for gathering specific plant resources, and communal hunting grounds. Her information on the other Southern Paiute groups, whose ranges bordered on or included portions of the Arizona Strip, is less comprehensive, but the Kaibab model appears to be generally applicable to the other bands as well.

From Kelly's study, we know that nineteenth century Southern Paiutes practiced a subsistence strategy based on seasonal transhumance. Highland areas such as the Kaibab Plateau were occupied during late summer and fall for the purpose of gathering berries, seeds, and pinyon nuts and for hunting large game. Extended family groups aggregated into larger units at this time of year. Rabbit drives were conducted in the valley bottoms and some large game, such as bighorn sheep and antelope, were hunted communally. Surplus food was cached in sheltered granaries for later use. As winter drew near, small extended family groups split off and moved to base camps at lower elevations in the pinyon juniper zone where winter fuel wood was plentiful. Proximity to springs (probably 1 to 3 km distant) was the primary factor controlling the selection of base camp sites. During the winter, periodic trips were made to the food caches that were usually situated in rockshelters. As winter abated and autumn food stores dwindled, the family groups moved to lower elevations in and adjacent to the Colorado River gorge where agave, cacti, and early spring greens could be procured. During the summer, the scattered families moved back to their base camps and gathered and hunted in the vicinity. Small patches of corn and squash were casually cultivated by some band members, and periodic foraging trips to higher elevations were also undertaken. As summer waned, small groups abandoned their base camps and moved on to the plateaus once again.

This model of the annual settlement-subsistence round should not be construed as a rigid pattern of seasonal movements. In fact, the Southern Paiute settlement-subsistence system exhibited considerable flexibility (Fowler 1982). The seasonal availabilty of key plant resources and the overall abundance of food resources influenced mobility patterns. During periods of abundance, fewer moves were required, whereas during lean years, individual family groups might forage over considerable distances, sometimes well outside their traditional use area. There were usually a variety of options to choose from, and the final decision was often based on social considerations in addition to subsistence needs (Fowler 1982).

Intimate knowledge of plant resources allowed the Paiutes to plan their annual round well in advance. For example, it was possible to judge the likelihood of a good pinyon harvest from the condition of the cones during the preceding year (Lanner 1981). If the harvest looked promising in one area, the bands might plan to meet there the following year. If the winter was exceptionally dry, however, the next year's crop would be significantly reduced over a broad region. In that case, alternative winter food sources could be gathered and stored during the summer and early fall in anticipation of the lean harvest ahead.

Kelly's (1964) description of nineteeth century Kaibab Paiute settlement-subsistence systems provides a useful model for analyzing prehistoric Paiute settlement-subsistence data from the Arizona Strip. Nevertheless, Kelly's reconstruction of aboriginal Paiute culture at the time of white contact is probably biased by the fact that none of her informants had first hand knowledge of the initial period of contact. Furthermore, indirect effects from the introduction of Old World diseases and technological items could have had a profound influence on aborginal cultures long before direct contact with Europeans occurred (Crosby 1972; Fowler and Fowler 1981:150).

Southern Paiute Horticulture

Ethnohistorical evidence suggests that horticulture diffused to the western Paiute bands via the lower Colorado River tribes (Fowler and Fowler 1981) and was initially restricted to well watered river bottoms. In 1826, Jedediah Smith found Paiutes cultivating fields at the junction of the Muddy and Virgin Rivers, within the territory of the Moapa Paiute band. Fifty years earlier, Escalante noted the presence of gardens along the Santa Clara River and Ash Creek in southern Utah, but none were seen during the journey across the Strip. During a brief encounter with a band of Uinkaret Paiutes west of Mount Trumbull, Escalante specifically inquired about the practice of cultivation and received a negative reply.

The Kaibab Paiutes claimed to have learned horticulture from the St. George Paiutes shortly before the arrival of Mormon settlers in the area (Kelly 1964). By 1869, when Powell came down the Colorado River, a small squash garden was located near the mouth of Whitmore or Parashant Wash within Uinkaret territory (Powell 1961). Powell and Ingalls (1874) reported that in 1873, all of the Paiute bands practiced horticulture. The timing of these events suggests that the acceptance of horticulture by the upland dwelling eastern bands may have been an historical response to the reduction of native grasses from livestock grazing during the 1800s (Stoffle and Evans 1976).

According to Kelly and Fowler (1986:371), the degree to which horticulture was practiced varied among Southern Paiutes. Ethnohistorical descriptions of irrigated corn fields along the Santa Clara River and lower Virgin Muddy River valleys suggest that crop cultivation constituted a significant subsistence activity among the St. George and Moapa Paiutes, while among the Kaibab and Uinkaret Paiutes, the contribution of cultigens to the diet appears to have been relatively minor. Within the various bands, only some families pursued this form of subsistence, and in all cases, horticulture was considered secondary to other subsistence pursuits.

Cultivation activities were readily integrated into the annual foraging round. Small gardens were planted near springs and along perennial streams, often in the vicinity of base camps. Some gardens were casually irrigated with shallow, earthern ditches. In some cases, the gardens were tended by older individuals who remained behind when the rest of the band departed on foraging expeditions. Other gardens were visited only sporadically or were left unattended over the course of the summer. At harvest time, the crop was shared by farmers and nonfarmers alike (Fowler and Kelly 1985:371).

Material Culture and Architecture

The mobility of Southern Numic bands precluded the development of an extensive or elaborate material culture or permanent architecture. Instead, Numic technology was characterized by functionality and portability. Items constructed of lightweight perishable materials (principally plant fibers, wood, horn, and hides) made up the bulk of material goods. Basketry was probably the most highly developed technology in terms of investment of production time and creativity. Hunting-related implements made of chipped stone undoubtedly were important as well, although little data pertaining to this aspect of Numic technology currently are available. In the case of heavy or nonportable items such as metates, ceramic vessels, and dwellings, Numics typically made opportunistic use of readily available materials, including Anasazi artifacts and structures (Stewart 1942; Fowler and Matley 1979; Fowler and Fowler 1981:141, 145). Kelly (1964) and Stewart (1942) document the full range of material goods manufactured and utilized by Southern Numics in the early historic era. In addition, detailed descriptions of two extensive collections of Southern Paiute artifacts are presented by Fowler and Matley (1978, 1979). For summary descriptions of Southern Paiute material culture, see Fowler and Fowler (1981) or Kelly and Fowler (1985).

Architecture consisted of simple conical brush structures. The most elaborate structures were built for winter habitation; summer structures involved little more than semi-circular brush shades or brush piled on living trees to create denser shade. Typical winter structures had circular floor plans 3 to 5 m in diameter and were usually constructed with three or four poles forming a tripod or quadripod 3 to 4 m high. Additional poles were leaned against the foundation, and brush, bark, or rushes were loosely lashed to the framework. Dirt was sometimes added over the brush to provide additional protection. Another form of architecture consisted of numerous poles planted at an angle into the ground and covered with brush and bark. Structures were also built around living trees, with branches serving as ridgepoles for the brush walls. Doorways generally faced eastward to take advantage of the morning sun (Kelly and Fowler 1986:371). Caves were also used for winter quarters by some groups (Kelly and Fowler 1986:371).

Diagnostic Artifacts

The perishable nature of most Numic artifacts, the lack of stylistic development in nonportable goods, the opportunistic use of raw materials and existing Anasazi artifacts, and the transiency of most site occupations make the identification of Numic occupations in the archaeological record exceedingly difficult. On open sites, occasional finds of pottery and distinctive projectile points provide evidence of Numic utilization. Of the two artifact classes, pottery provides the most reliable indication of Numic affiliation because it is fairly distinctive and, due to its rather crude construction, we can safely assume that it was not widely traded or reused by other cultural groups. Southern Paiute Brown ware was originally described by Baldwin (1950b) with subsequent revisions by Euler (1964), Hunt (1960), and Fowler and Matley (1978). Sherds of Jeddito Black-on-yellow are sometimes found in association with Southern Paiute Brown ware; even when found in isolation, these widely traded Hopi sherds are probably indications of Southern Paiute activity (Baldwin 1944; Schaefer 1969).

The Desert Side-notched projectile point is the point type most commonly associated with Southern Numic sites (Fowler and Matley 1979; Holmer and Weder 1980). As a temporal horizon marker, Desert Side-notched points are widely accepted as being indicative of the Late Prehistoric, Protohistoric, and Early Historic periods. In southeastern Nevada and southwestern Utah, these points have been recovered from stratified shelter deposits radiocarbon dated to A.D. 1150-1300 (Fowler et al. 1973). Farther to the south and east, this point apparently is restricted to the post A.D. 1300 period.

In sheltered sites containing Southern Numic pottery and Desert Side-notched points, basketry artifacts may provide corroborative evidence of Numic utilization. Southern Paiute basketry is characterized as a mixed twined and coiled industry (Fowler and Fowler 1981). Twining is predominantly two-rod diagonal twist, while coiling usually is three-rod bunched with noninterlocking stitches (Fowler and Fowler 1981:145-146). The industry has obvious ties with historic Great Basin and southern California traditions, and shows little or no connections with Fremont or Anasazi basketry technology (Adovasio et al. 1978; Adovasio 1980:39). Readers desiring more detailed descriptions of Southern Paiute perishable artifacts can refer to Fowler and Matley (1978, 1979) and Fowler and Fowler (1981).

Southern Paiute Sites on the Arizona Strip

Despite ample historic documentation of Southern Paiutes on the Arizona Strip, relatively few Paiute sites are recorded in the area. As noted previously, this is probably a reflection of the inability to recognize Paiute sites in the absence of points or ceramics. The fact that most identifications of Paiute sites in the BLM and USFS site files are based on the presence of Southern Paiute Brown ware sherds supports this supposition. The sites recorded to date include open and sheltered camps, mescal pits, caches, and isolated pot drops. Many of the undated mescal roasting pit sites recorded on the benchs and in the lower canyons along the north rim of Grand Canyon probably date to the Neo-Archaic period also.

Few Neo-Archaic structural sites have been recorded on the Arizona Strip to date. Most consist of relatively recent Navajo or Paiute pinyon nut gathering camps with brush shades (USFS site files). Some of the undated sites with rock rings recorded in the BLM site files may date to this period. These features are sometimes identified as tipi rings, and in some cases, this classification may be accurate. During the late 1800s, hide and canvas tipis were adopted from the neighboring Utes. By this time, many Paiutes were living in houses in the vicinity of the Mormon towns, and the tipi was mainly used for summer fall food gathering trips (Stoffle and Evans 1978). More commonly, however, these rock rings may be indicative of wickiup foundations. An eighteenth century wickiup site is reported from the Beaver Dam Mountains of southwestern Utah; presumably, similar sites are also present within the project area (Moffitt et al. 1978).

CHAPTER 5

HISTORY

Helen C. Fairley

History on the Arizona Strip begins in 1776 with the first documented explorations of the region north and west of the Colorado River by members of the Dominguez-Escalante expedition. The following two centuries can be conveniently divided into two periods: the Spanish-Mexican period (1776-1848) and the American period (1848-1945). The Spanish-Mexican period encompasses the discovery and subsequent use of existing Indian trails by early Spanish explorers, followed by Mexican traders and American fur trappers. To these early visitors, the Arizona Strip was little more than an obstacle to be overcome while en route to other destinations. Nevertheless, these initial forays opened the way for later penetration of the region by farmers, cattlemen, and miners. The effects of progressive European encroachment upon the Native American inhabitants of the region constitute an important theme throughout the Spanish-Mexican period.

It was not until Americans gained control of the Southwest that the first permanent Anglo settlements were established in the area. Following a decade and a half of Mormon exploration, ranching outposts were established at Short Creek, Pipe Springs, Moccasin and Parashaunt during the 1860s. A settlement on the lower Virgin River and a major wagon road were also established at this time. Aggressive responses by Native American inhabitants towards these initial developments played a critical role in curtailing Mormon expansion during the 1860s, but by the beginning of the 1870s, settlement of the area was proceeding at a rapid pace. Other important activities during this phase of the American period included federally sponsored explorations of the region by John Wesley Powell and Lt. George Wheeler, the evolution of political and administrative boundaries, and the expansion of ranching, lumbering, and mining activities. The U.S. Forest Service and National Park Service played an increasing role in administering grazing, mining, lumbering, hunting, and recreational activities in the area during the early 1900s. The marked increase in homestead filings that followed passage of the 1916 Stock Raising Act is another pivotal development of this period. Significant events during the latter part of the historic period include the passage of the Taylor Grazing Act and the creation of the Grazing Service (forerunner of the BLM), range improvements and trails constructed by the Civilian Conservation Corps, expansion of the tourist industry, and the ongoing adjustments of the local Native American populace to these various historical developments.

SPANISH-MEXICAN PERIOD, 1776-1848

Spanish Exploration

On July 29, 1776, a party of Spanish explorers departed from Santa Fe, New Mexico, with the primary objective of establishing a route between the New Mexican capitol of Santa Fe and the newly established capitol of Alta California at Monterey. In addition to strengthening the northern frontier by linking the two frontier capitols of New Spain, the expedition sought to expand the influence of the Catholic church among the native inhabitants of the territory and locate suitable sites for establishing future missions and settlements (Briggs 1976:34-35). The 12 member expedition was led by Fray

Atanasio Dominguez, chief inspector of the Franciscan missions in New Mexico. His prinicipal assistant and the expedition recorder was Fray Silvestre Velez de Escalante, formerly head of the mission at Zuni, New Mexico. Don Bernardo de Miera y Pacheo, a Spanish nobleman of many talents, served as the expedition astronomer and cartographer. Two traders of mixed Hispanic Indian ancestry served as guide interpreters. A Zuni magistrate, a blacksmith, and several servants completed the entourage.

Escalante's diary provides historians with a detailed description of the terrain traversed by the expedition. In recent years, several attempts have been made to retrace the expedition's path through Colorado, Utah, and the Arizona Strip with the aid of the diary. In 1928, Herbert E. Bolton documented the padres' trail through Utah and the Arizona Strip, and in 1950 he published an account of the entire journey (Bolton 1928, 1950). In 1975, the Dominguez-Escalante Bicentennial Commission hired a group of historians to retrace the route a second time using a new translation of the diary (Warner and Chavez 1976). Although this second study modified some of Bolton's conclusions regarding the location of specific campsites, there is considerable agreement between the two. Since many of the camp locations can be readily identified in reference to existing landmarks, a detailed account of the expedition's route through the Arizona Strip is included below (Figure 44).

On October 11, after two and a half months of arduous travel, the expedition found itself on the eastern edge of the Great Basin with more than half the distance to Monterey still before them. Short on supplies and faced with the rapid approach of winter, the weary explorers decided to turn back. Rather than retrace their circuitous route through northern Utah or attempt a crossing of the Wasatch Range to their east, the party elected to turn south. This decision was based on the knowledge that the Colorado River lay somewhere to the south and that this river would eventually lead them back to familiar territory (Bolton 1928:47).

Traveling south towards the Colorado, the expedition camped on Ash Creek near the western border of Zion National Park on the night of October 13. Passing present day Toquerville, the group reached the Virgin River (Rio Sulfero) at the deep gorge (Bolton 1950:203). Unable to cross at this place, they retraced their route about a quarter of a league (1.2 km) to the junction of Ash Creek and the Virgin River, then proceeded over the present townsite of Hurricane before camping on Hurricane Wash approximately .4 km north of the Arizona line. Located where Hurricane Wash cuts through a low hogback, this camp was named San Donulo (Warner and Chavez 1976:80; see also Bolton 1950:206).

The group had depleted their supplies by this time, and Escalante reported in his journal that they had only two cakes of chocolate to divide among themselves. In addition to finding a route through unknown territory, the Spaniards were now faced with the necessity of procuring sustenance as well. The next day the party encountered a group of Paiutes on the hogback ridge overlooking their campsite. The Paiutes indicated that they were from a band of cultivators residing in the vicinity of Ash Creek. They advised the explorers against proceeding southward because water was scarce, the terrain rough, and the river could not be crossed because of high cliff walls. Instead they directed the expedition to follow Rock Canyon eastward through the Hurricane Cliffs. The Spaniards heeded this advice, but the recommended route proved to be impassable for horses and the explorers were forced to backtrack. That night they camped near the mouth of Cottonwood Canyon on the east side of Hurricane Wash, less than 6.5 km south of the previous night's campsite. On October 17, they proceeded through Black Rock Canyon and emerged into Lower Hurricane Valley. Diamond Butte, Solitaire Butte, and Mt. Dellenbaugh were in their view. The expedition continued about 8.5 leagues (41 km) along the base of the cliffs, then veered eastward up an arroyo bed and swung south up a branch for approximately 100 m to the first landing on the mesa, where they continued upslope to a second landing. Camp was made at a dry arroyo running west from the mesa top. This camp on top of Hurricane Cliff was named San Angel.

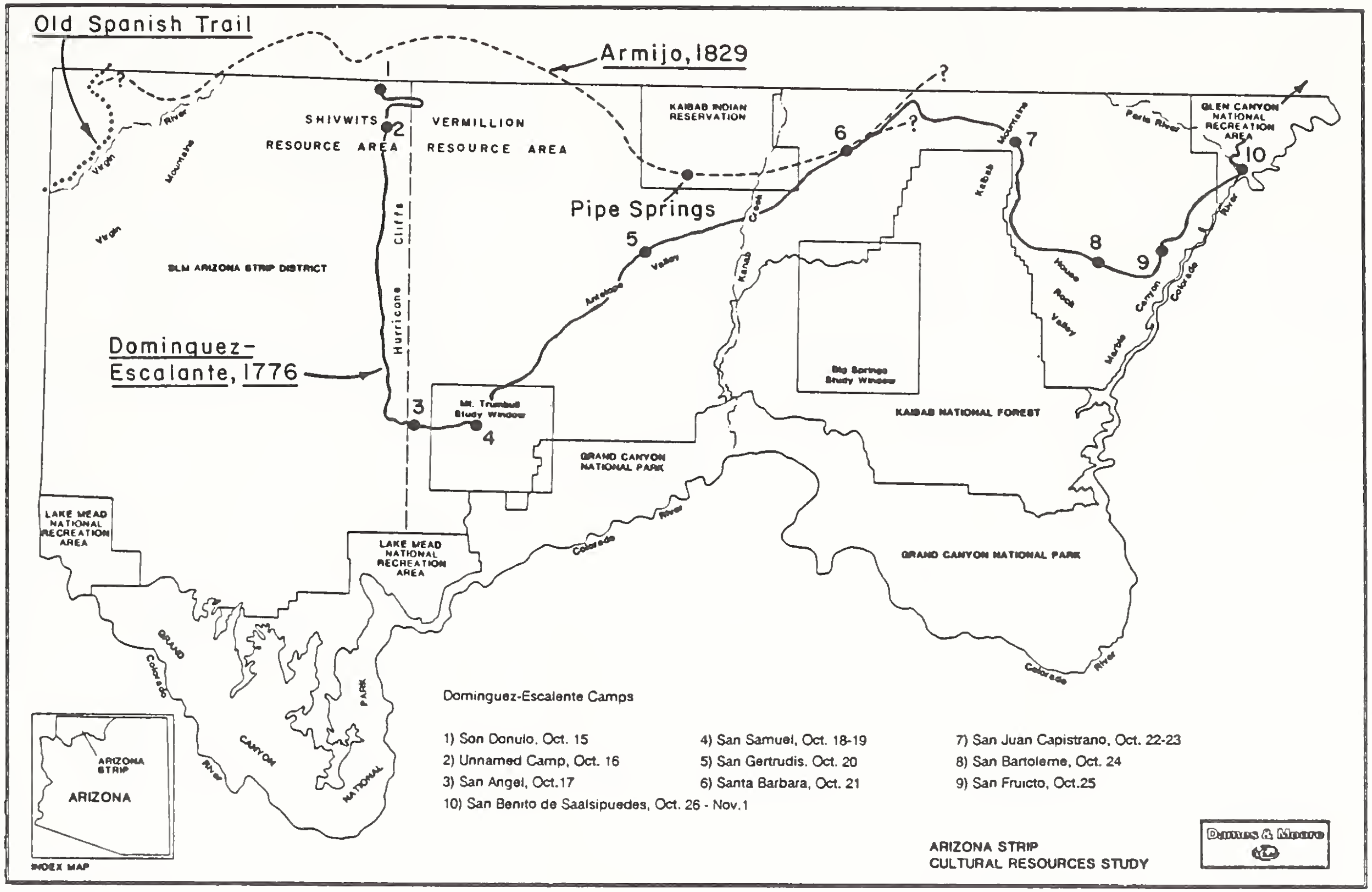


Figure 44. Escalante's Route through the Arizona Strip, 1776

On October 18, the party traveled east southeast. As they were looking for water they observed "five Indians spying on us from a small but high mesa" and when Escalante could not convince the Indians to join them, the Franciscans climbed the little hill to talk with them. After promising to trade cloth to the Indians, they were guided about a league south to an arroyo "where deep holes held two large pools of water." Camp San Samuel was made at the mouth of Bobcat Canyon (Bolton 1950:211; Warner and Chavez 1976:85).

The party remained encamped at San Samuel for two nights while some members of the group went in search of additional food and water. The padres eventually succeeded in purchasing some additional provisions from a band of Paiutes residing in the area. Upon leaving San Samuel, the group changed direction and traveled in a north-northeasterly direction toward the northwest flank of the Kaibab Plateau. According to Bolton (1950:213), the camp named Santa Gertrudis was situated in Antelope Valley on one of the western tributaries of Kanab Creek. Warner and Chavez (1976:87) maintain that Escalante's description of the camp's location "at a point where the two sides of the hogback appear as bluffs" coincides with a position on Bull Rush Wash. In any case, there is no indication that the expedition got as far north as Pipe Springs (cf. Olsen 1965:11).

After camping on October 21 in Kimball Valley near Johnson Creek, approximately 8 km southeast of Fredonia, the party crossed over the Kaibab Plateau and descended into Coyote Valley (Warner and Chavez 1976:88). Water was located on the night of October 22 near "three little Indian huts." This camp, San Juan Capistrano, was situated a short distance east northeast of Coyote Spring (Warner and Chavez 1976:89; see also Bolton 1950:214). On October 24, after laying over a day in the Paiute camp at Coyote Spring, the expedition passed through the divide separating Coyote and House Rock valleys and traveled 9 leagues (ca. 43 km) south-southeast before making camp. This camp, San Bartolome, was situated on Emmett Hill, between House Rock Wash and Emett Wash, immediately west of the southernmost point of the Paria Plateau. Proceeding east, then north-northeast, along the base of the Vermilion cliffs, they eventually encountered a cottonwood grove marking water. Although there was a saltpeter- like substance around the edge of the pool, they found the water potable and camped for the night. This camp, San Fructo, was on the right side of Soap Creek Canyon, approximately 25 m upstream from where Highway 89A crosses the wash (Warner and Chavez 1976:93; see also Bolton 1950:218).

Continuing along the base of the cliffs on October 26, the group arrived at the junction of the Paria River (Santa Teresa) with the Colorado River (Rio Grande de Cosninas). They crossed the Paria and camped on the banks of the Colorado River near a high cliff of gray rock, naming the campsite San Benito Salsipuedes -- "get out if you can." The explorers stayed here for five days while attempting to swim across the river, but after several near drownings, they abandoned hope of crossing at this point. On November 1 they decamped and followed the Paria River upstream. They spent the night on the bank of the river at the foot of an acclivity about 4.8 km up the Paria from its junction with the Colorado River. The next day they climbed the acclivity which they called Cuesta de las Animas. Today this break in the cliffs is called Dominguez Pass, and the entire route over the cliffs is known as the Dominguez-Escalante Trail.

The Dominguez-Escalante expedition left the Arizona Strip on November 2, 1776. During the next 4 days (3-6 November), the Spaniards traveled near the river, stopping twice in Glen Canyon (San Carlos and an unnamed camp) and near Warm Springs Canyon (Santa Francisco Romana). Finally, on November 7, the explorers found a way down to the river at a wide, shallow place and achieved their long sought goal: a safe crossing of the Colorado River. They christened the crossing La Purisima Concepcion de la Virgen Santisima. (Later Hispanic travelers named it "El Vado de los Padres" or "The Crossing of the Fathers," and historic Indians and nineteenth century Mormons referred to it as the Ute Ford.) After several more days of hard travel, the expedition arrived at the Hopi villages, and from this point on, the party traveled through known country, stopping at Zuni before reaching Santa Fe on January 2, 1777 (Bolton 1950:200-226).

Although the attempt to establish a route to Monterey was a failure, it opened the door to this previously unknown region. The expedition compiled considerable information concerning the lay of the land, the nature of the Indians, water and forage conditions, and river fords. Several copies of Escalante's diary were made, and Miera y Pacheo produced an elaborate map of the territory through which they had traveled. Although these documents were not publicly disseminated, information about the journey spread by word of mouth. In 1811, Alexander von Humbolt published a popular map of western North America that drew heavily upon the earlier work of Miera y Pacheo (Briggs 1976:189-190). Ultimately, the information gathered by the 1776 expedition proved to be of great value to later Mexican traders and American trappers.

Mexican Exploration and the Old Spanish Trail

With the independence of Mexico from Spain in 1821, republican politics replaced monarchical despotism. The change in government resulted in a number of policy changes as well. The Jesuit and Franciscan orders were replaced with secular priests, local militia assumed the burden of frontier defenses, private land ownership increased, ranches and townships grew in importance, and new routes of trade and communication opened up as economic restrictions slackened.

With independence came an invigorating laissez-faire spirit and a rapidly developing regional commerce. Entrepreneurs readily recognized the economic advantages of linking the two population centers of Santa Fe and Monterey. By the mid-1830s, Mexican traders were traveling regularly between these two provincial capitols. Influenced by earlier explorers, they favored a northern route out of Santa Fe. Despite being a rigorous journey, this route had two distinct advantages: the country it passed through was relatively well known and it bypassed hostile Indians, specifically the Hopi and to a lesser extent the Navajo. From this time until the Mexican War (1846- 1848), the Old Spanish Trail (as it would later be called) was the most heavily traveled route between New Mexico and California. Twelve hundred miles long, it was "the longest, crookedest pack mule route in the history of America" (Hafen and Hafen 1954:19).

The trail started at Santa Fe, wound its way west and northwest through central Utah, crossed the Colorado and Green rivers near the present day communities of Moab and Green River, then crossed the Wasatch Range and followed the Sevier River to its junction with Clear Creek. The route continued up this fork to the divide separating the drainages of the Sevier and Virgin Rivers, then descended into the Parowan Valley and followed Ash Creek down the natural corridor between the Hurricane Fault and Pine Valley Mountains to its confluence with the Virgin River. It continued along the Virgin River, with a detour around The Narrows via the Beaver Dam Mountains and Beaver Dam Wash, to the confluence with the Muddy River. At this point, it cut westward across the Mohave Desert by way of Las Vegas Springs and the Mohave River to California. In later years, when the trail was developed for use by wagons and became known as the Mormon Road, a short cut was developed that followed the Santa Clara River to its headwaters in the Mountain Meadows, then cut over to Meadow Valley Wash and proceeded south from there to Las Vegas Springs, entirely bypassing Arizona.

In truth, only the eastern half of the trail, from Santa Fe to the Parowan Valley of Utah, properly deserved to be called "old" or "Spanish" (Hill 1930). Beginning sometime in the late eighteenth century, Spanish and Ute traders traveled the trail between Santa Fe and the eastern Great Basin, exchanging guns and horses for furs and human slaves. But it was Mexicans and Americans, not the Spanish, who first opened the trail all the way to the Pacific Coast and ultimately defined it on the maps. In 1826, while pioneering a route to California, Jedediah Smith first traversed the segment of the Trail that passed through the northwestern corner of the Arizona Strip. On this trip, Smith followed the Virgin River along its entire course below the junction of the Santa Clara to its junction with the Colorado River (Hafen and Hafen 1954:116). During a second traverse in 1827, he found a way to bypass the rugged Virgin River gorge by cutting over the Beaver Dam Mountains and then proceeding down Beaver Dam Wash, reconnecting with the Virgin River near the present site of Littlefield, Arizona.

> I crossed the Mountain without any difficulty and crossing some low Ridges struck a Ravine which I followed down to the bed of the dry River [Beaver Dam Wash] which I called Pautch Creek which I followed down to the Adams River [Virgin River] about 10 miles below the Mountn [sic] [Sullivan 1934:28].

Smith followed the Colorado River down to the Mohave villages near present day Needles before striking out across the desert. This route ran considerably farther south than the one that would later become known as the Old Spanish Trail.

The honor of opening the westernmost segment of the Trail belongs to a Mexican trader named Antonio Armijo. In 1829, Armijo led the first commercial pack train from Sante Fe to California and back, thereby demonstrating the economic viability of linking the two northern provinces of Mexico. Instead of following the established track through central Utah, however, Armijo took a more southerly and less traveled route. In doing so, Armijo completed the first documented traverse of the Arizona Strip since the Dominguez-Escalante expedition.

Although his published diary is brief and his geographic descriptions vague, it is possible to reconstruct his trip from Santa Fe (Hulbert 1933). Using Indian guides, and accompanied by Mexicans who had probably traveled some part of the route before, Antonio Armijo left Santa Fe on November 7, 1829, 53 years to the day after Dominguez and Escalante had crossed the Colorado River. Carrying woolen blankets, cloth, gold, and silver, Armijo headed northwest from Santa Fe. His route took him through the southwestern corner of Colorado, just to the south of the present Mesa Verde National Park boundary, and into northeastern Arizona. On 6 December 1829, Armijo and his men crossed the Colorado River at the "Crossing of the Fathers." Armijo mentions that the padres' carved steps were visible, and the diary entry leaves one with the impression that several of Armijo's men recognized the crossing and that all knew it as a landmark--an established point on the trail west.

Armijo's decription of the route from the river west is a bit vague, but most historians agree that he followed the same general route as Dominguez and Escalante as far as the vicinity of Fredonia and then proceeded westward along the base of the Vermilion Cliffs. On December 15, the party camped at Pipe Springs, which they called "Agua de la Vieja." They then proceeded across "the Coyote Plains." The party camped at "Limestone Canyon" (Rock Canyon?) a place named "Stinking Water" (LaVerkin Springs?), and another site on the "Cornfields River" (Santa Clara?). The group then followed the Virgin River south through Arizona and Nevada until it joined the Colorado. From this point, they pioneered the western segment of the trail by way of Las Vegas Springs to Cajon Pass and then on to Los Angeles (Hafen and Hafen 1954).

In 1830, William Wolfskill, an experienced trader and trapper, became the first person to travel the entire length of the Old Spanish Trail from Santa Fe to Los Angeles (Hafen and Hafen 1954). Wolfskill established the connecting link between the Dominguez-Escalante trail and Armijo's route to Las Vegas Springs by way of the Santa Clara River and Mountain Meadows. During the following two decades, hundreds of trappers followed this route to California. Unlike the Oregon Trail to the north, which was mostly used by emigrants, the Old Spanish Trail was primarily a commercial route. Among the men who traveled this route are the most famous characters in the brief (1822-1840) history of the western fur trade (Weber 1971).

Mexico's policy regarding colonization was to move entire planned communities and presidios onto the frontier at specific locations where there were known agricultural or mineral locations. The Arizona Strip did not offer either of these qualities to the Mexican government, which was in any case principally concerned with its colonies in New Mexico and California. Problems in Texas by 1836, followed by mounting tension with the United States, increasingly occupied the attention of the Mexican republic.

In the early 1840s, as territorial pressures mounted on the western frontier and war with Mexico appeared imminent, United States military officials grew increasingly uneasy over the lack of specific geographic knowledge concerning the region west of the Rocky Mountains. Recognizing that this ignorance would be a serious liability in any future confrontations with Mexico, a series of exploratory expeditions were organized through the U.S. Army War Department (Goetzmann 1966). The first and perhaps most famous of these surveys was led by John C. Fremont. Beginning in 1842, and again in 1843-1844 and 1848-1849, Fremont completed a series of exploratory traverses across the Great Basin to the Paific Coast. On his return from the Great Basin in 1844, Fremont followed the Spanish Trail to the vicinity of the Virgin River, then followed in the footsteps of Jedediah Smith up from the mouth of the Virgin River to its junction with Beaver Dam Creek, then across the Beaver Dam Mountains to the headwaters of the Santa Clara River. Fremont thereby became the first official representative of the U.S. Government to traverse a portion of the Arizona Strip.

When war broke out between the United States and Mexico in 1846, American military forces abandoned the Old Spanish Trail in favor of a more direct southern route to the Pacific via the Gila River. An exception was the Mormon Battalion, which traveled to southern California by way of this route in 1847. Following the accession of Mexico's northern provinces under terms of the 1948 Treaty of Guadalupe Hidalgo, the Battalion returned on the same trail. The following year, Americans seeking their fortunes in the gold fields of California poured westward, but most of the 49ers bypassed southern Utah and northern Arizona by following more northern or southern routes. Once again the Arizona Strip country was all but forgotten--but this time it was for a much shorter period of time.

Impacts on the Southern Paiute During the Spanish Mexican Period

The impacts of eighteenth century Spanish explorations and nineteenth century trapper, trader, and military excursions upon the indigenous inhabitants of the Arizona Strip is difficult to assess due the paucity and uneven quality of historical documentation pre-dating the mid 1800s (Euler 1966). Initial contacts between Native Americans and Europeans in other areas of the American Southwest were often traumatic, ultimately resulting in significant modifications to the indigenous cultural system, and similar processes apparently affected the Southern Paiutes living on the Arizona Strip. The rapid spread of contagious Old World diseases among Native American populations, often well in advance of initial direct contacts with European colonists, was one major consequence of the European arrival in the New World (Crosby 1972). Lacking natural immunity to the newly introduced organisms, native populations rapidly succumbed. Crosby argues that the death rate from disease during the first two centuries following the arrival of European colonists in North America far exceeded the 10 percent level implied by the term decimation. Although precise documentation concerning the effects of Old World diseases on the Southern Paiute is hard to come by, inferential evidence is available.

Drawing on a wide variety of sources, Stoffle and Evans (1976:5) argue that a significant population decline occurred among the Southern Paiute bands of the Arizona Strip prior to 1850, due to epidemics of Old World diseases and extensive slave raiding by Utes, Navajos, and Anglos. They estimate that the prehistoric Kaibab Paiute population, occupying a territory of 4,824 square miles, numbered around 5,500 indivduals. This calculation is based on Dobyns' (1976:13) argument that nowhere in North America could aboriginal population have been less than the 1.12 persons per square mile recorded by Aschmann (1959:177-180) for the central desert of lower California. Kelly (1934:25) estimates that by the mid-1800s, the Kaibab Paiutes numbered around 500 individuals. Using population density figures compiled by Steward (1938:49) for the neighboring Sevier Lake and Sampits Utes (2.6 and 4.0 sq mi per person), Stoffle and Evans (1976) maintain that Kelly's estimate is too low and suggest a mid-nineteenth century Kaibab population figure of 1,200 to 1,800 individuals. Depending on which figures are used, a population decline of 65 to 90 percent during the century between about 1750 and 1850 is indicated.

The impact of slave raiding on the Southern Paiutes prior to the nineteenth century is similarly difficult to evaluate. Escalante commented on the apparent timidity of the Southern Paiutes (Warner and Chavez 1976), as did other early historic observers, and it has been suggested that this behavior was a direct outgrowth of relentless slave raiding by neighboring tribes (Malouf and Malouf 1945). According to Brugge (1968:19) Paiutes were being used as slaves in the Spanish colonies of New Mexico by the late 1700s; however, the first historical documentation of Paiute slaves in the Spanish colonies dates to 1810 (Kelly and Fowler 1986:386).

Certainly by the beginning of the nineteenth century, slave raiding was having a profound impact on the population size and aboriginal lifestyle of the Southern Paiute. The expansion of the fur trade and extension of the Old Spanish Trail to California exacerbated the situation. The Ute bands to the north of the Southern Paiute capitalized on the opening of the Spanish Trail by exacting tribute from traders passing through their territory (Alley 1982). Initially, they traded furs for guns, but as furs became depleted, the trade in slaves grew increasingly profitable. Some Spanish and Anglo traders also participated in slave raiding. According to Thomas Farnham, a trader in the 1830s, Paiutes were "hunted in the spring of the year, when weak and helpless, by a certain class of men, and when taken, are fattened, carried to Santa Fe and sold as slaves during their minority" (Kelly and Fowler 1986:386). Indian agent, Garland Hurt (1876:462), commenting on the effects of the early nineteenth century slave trade, noted that "scarcely one half of the Py-eed children are permitted to grow up in a band; and a large majority of these being males, this and other causes are tending to depopulate their bands very rapidly." This endemic slave raiding not only reduced the indigenous Paiute population, but it also apparently drove the surviving Paiutes away from established base camps, where they were most vulnerable to attacks, and may have encouraged a more mobile settlement strategy. The situation was exacerbated by the increased traffic of commercial caravans over the Old Spanish Trail, most of which were accompained by large herds of sheep and horses. The intensive use by livestock rapidly despoiled the area around major springs, some of which the Paiutes' farmed and most of which served as seasonally occupied residential base camps (Kelly 1964). These two factors--slave raiding and the influx of livestock caravans--may explain why certain ecologically favorable areas of the Southern Paiute territory were reported to be devoid of inhabitants in the early 1800s (Euler 1966:46ff).

AMERICAN PERIOD, 1848-1945

Colonization in the State of Deseret

Fully one year before the United States government took title to the western lands acquired from Mexico through the Treaty of Guadalupe Hidalgo (1848), American emigrants had already settled around the Great Salt Lake. Under the leadership of Brigham Young, converts to the Church of Jesus Christ of Latter-day Saints (LDS) began arriving in the area in 1847. The Mormon emigrants to Utah were looking for an isolated area in which they could securely practice the tenets of their religion. Brigham Young was familiar with John C. Fremont's journal of his 1842 exploration expedition as well as the famous guidebook by Lansford W. Hastings, The Emigrants' Guide to Oregon and California; he knew of the towering mountains blocking access from the east and the arid deserts providing an effective barrier to the west and south.

Although technically within the territorial domain of Mexico, this area was in fact separated politically and geographically from both the United States and Mexico. In this sense, it was perfectly suited to Brigham Young's vision of a Mormon controlled state that would be the embodiment of God's Kingdom on Earth. The State of Deseret, as Young envisioned it, would include all of the present states of Utah and Nevada, the northern half of Arizona, and substantial portions of New Mexico, Colorado, Wyoming, and California. Establishing control of this vast territory would require a concerted, well organized, and efficient program of colonization.

Soon after the Mormons arrived in Utah, Young set about implementing his ambitious plan. The colonization of southern Utah was directed by the church leaders in Salt Lake City and was as much a religious activity as a practical matter. Colonization was consistent with church doctrine and tied to the Mormon belief that missions were "callings" or moral obligations incumbent on a chosen people (Peterson 1973:38). Indeed the history of the church is fundamentally intertwined with the colonization process. Immigrants from the Salt Lake City area and surrounding towns were usually eager to move, because ready acceptance of a calling provided proof of one's faith.

Initial settlement in the Salt Lake valley and later on the Arizona Strip was governed by a program revealed by Young in the fall of 1847. He told his followers that no longer could each person live where he chose or farm as he wished. Instead they would dwell together and work together under the leadership of their church. Their homes would be in the city (Salt Lake to start and others to follow) and the city would follow a plan he and the Twelve Apostles had devised. The streets, surrounding what amounted to a 10 acre village green, would be wide, marking off blocks of 10 acres, and each block would be subdivided into eight lots for houses and gardens. Each family would be assigned a lot. There would be no sale of land and no private ownership of streams or timber or anything else essential to the social welfare of the group. All farming would be done in tiers around the city and irrigation would be strictly controlled.

Using this Salt Lake City plan as a model, colonization was coordinated, planned, and efficient. Indeed, Young's colonization process was the most efficient and successful in the history of the frontier. When a new outpost was planned, an advance party was sent out to survey the terrain, select a townsite, locate irrigation ditches, and mark out farms. Then settlers were carefully selected- or "called"- with a bishop at their head, and a proper proportion of farmers, shopkeepers, blacksmiths, and other skilled workmen to provide a well balanced labor force. The company usually included a mix of families experienced in the colonization process and newcomers to Utah who would profit from their brothers' and sisters' examples (Billington 1956:193-219).

In addition to establishing territorial claims for the State of Deseret, a secondary reason that motivated Mormon settlement of southern Utah and the Arizona Strip stemmed from the Mormon desire to convert the Indians. When Joseph Smith first published the Book of Mormon in 1830, he offered a special reason for concern for the Lamanites, as he called the Indians. They were part of the people originally chosen by God, but due to their disobedience to God's word, they had fallen from grace. As punishment, God had caused their skin to darken. The Mormons had an obligation to return these people to their rightful place as God's chosen group, whereupon they would become once again "a pure and delightsome people."

Early on, Mormon elders embarked on a policy establishing outpost missions among the Indians. Each mission was manned by 30 to 40 people charged with teaching the Indians the Mormon religion and demonstrating to them the most efficient means of farming. Mormon missionary farmers lived among the Indians and attempted to civilize and convert them through example. To protect themselves, the Mormon missionaries settled initially in fort like structures, and they appointed a certain number of individuals who could speak the native languages to conduct all trading for the Mormons. This kept Indians from roaming around Mormon settlements and eliminated competitive trading between Mormon settlers (Ricks 1964).

In April 1854, Brigham Young issued a call to establish a mission colony among the Indians in southern Utah. Among those called was Jacob Hamblin, the "Buckskin Apostle," who would later play a prominent role in opening the Arizona Strip to settlement. Two years previously, John D. Lee had established the town of Harmony, located 20 mi south of Cedar City, and from this base, Hamblin and Lee made exploratory journeys south into the Indian lands. By June 1854, Hamblin and several others had established a mission among the Paiute bands of the Virgin and Santa Clara Rivers. From these bases in southwestern Utah, the Mormons ventured southward on to the Arizona Strip.

Mormon Explorations on the Arizona Strip

In the two decades following Mexico's cession of its northern territories to the United States, federally sponsored exploratory expeditions were conducted throughout the intermontane west to study and map the newly acquired territory and to establish potential transcontinental transportation routes for California-bound wagon trains and, later, for railways. Through the hearsay accounts of Mexican and American trappers and traders, enough was known about the rugged landscape bounding the Colorado River system to deter serious consideration of the Arizona Strip region as the location of a major transportation route. Although some information was gleaned about the regional topography north of the Colorado River through the long distance observations of Lieutenant Ives (1861) and from Fremont's 1844 traverse along the Virgin River, the area remained officially unexplored until Major John Wesley Powell undertook his pioneering topographic survey of the Arizona Strip in 1871-1873.

Although the region north of the Colorado River was being ignored by U.S. Government explorers, Mormon missionaries took an active interest in the area. Between 1852 and 1864, they initiated a series of reconnaissance expeditions to scout out the territory lying south and east of their missions in southern Utah (Woodbury 1944; Crampton 1965). Lee led the first of these expeditions in late January, 1852. After exploring the Santa Clara Valley and crossing over the Beaver Dam Mountains into the Virgin drainage, Lee and two others worked their way upstream through the Virgin Narrows, returning to Parowan in mid February. Another expedition set out from Parowan in June, 1852, under the leadership of J.C.L. Smith and Jesse Steele, with John D. Lee along as interpreter. They traveled in a broad clockwise loop through the country surrounding present day Zion National Park and eventually emerged in the vicinity of Cane Beds near the Arizona-Utah line (Woodbury 1944:142). In the spring of 1858, another exploratory expedition retraced a portion of the 1852 expedition's route, crossing over the "Elephant Hill" south of the Virgin River and emerging on the open plains near Cane Beds.

> Turning right, they traveled until sunset when they came to a short creek, the bed of which was dry. Turning up the "broad, smooth wash" they finally found water.This appears on the expedition chart as "Short Creek." It is probably identical with the drainage now called by the same name and it is this event that accounts for the origin of that name (Crampton 1965:86)

A date of 1857 and the names C.E. Holladay and G.A. Huntington inscribed on a sandstone boulder below Fischer Springs, near the present site of Lees Ferry, testify to the presence of some other early American travelers in the area. The association of these names with early Mormon missionaries cannot be securely established (Crampton 1965:93). It is possible that these inscriptions were left by non-Mormon prospectors who were reported to have crossed the river from the south end of Buckskin Mountain during this year (Gregory 1939:75).

By the time Jacob Hamblin undertook his first missionary expedition to the Hopi in the fall of 1858, the country at least as far east as Short Creek had been visited on one or more occasions. Since the region beyond that point remained essentially unknown, Hamblin enlisted the aid of a local Paiute named Naraguts to guide them across the Strip. Hamblin and his team of missionaries left Santa Clara in late October. They surmounted the Hurricane Cliffs and proceeded eastward along the base of the Vermilion Cliffs towards the Crossing of the Fathers. On the third night out, they camped at Pipe Springs (then unnamed) with a band of Kaibab Paiutes, then continued eastward along the base of the Vermilion Cliffs to the foot of the Kaibab Plateau. In his later report on the expedition, Hamblin referred it as "Deer Mountain" (Corbett 1952:162). The route they followed over the plateau is uncertain; Reilly (1978:382) suggests that they followed Jacob Canyon to the vicnity of Jacob Lake, then descended the east flank via Trail Canyon. They then proceeded down House Rock Valley and on around the base of the Paria Plateau Cliffs to the mouth of the Paria River.

After scouting the crossing, the Paiute guide realized that he had made a mistake by bringing them down to the river well below the Ute Ford. Following in the footsteps of the Dominguez- Escalante expedition, the company then turned up the Paria and followed the trail through the Echo Cliffs, which eventually brought them to the Ute Ford 30 miles above the mouth of the Paria. Upon arriving in the Hopi villages, they found the Hopi polite but recalcitrant, and within a few days, they started back to their mission on the Santa Clara. It was on the return journey that a member of the expedition, Andrew Gibbon, first used the name "Buckskin Mountain," the name still used locally to refer to the Kaibab Plateau (Reilly 1978:380).

It was on this same journey that Pipe Springs allegedly acquired its name, in commemoration of a stunning feat of marksmanship. According to local legend, several members of the expedition made a bet with Jacob's sharpshooting brother, William "Gunlock" Hamblin, that he could not pierce a handkerchief at 25 paces. Unbeknownst to him, the target was made of silk, and the bullets simply pushed the cloth aside. When the joke was revealed to him, "Gunlock" appropriated Dudley Leavitt's smoking pipe for a new target, measured off fifty paces, took aim, and promptly shattered the pipe. (Some versions of the legend claim that he laid the pipe on its side and shot out the bottom without hitting the sides.) This exhibition reportedly took place while the group was encamped at the springs. Although the episode cannot be confirmed through documentary sources, the name Pipe Springs was definitely in use by the following year (Brooks 1944b:73).

Hamblin made several more journeys to the Hopi villages along this trail. In 1859, he and five other Santa Clara missionaries attempted the journey with a boat loaded on an ox cart, but the boat had to be abandoned at the foot of the Hurricane Cliffs. The missionaries continued on horseback to Pipe

Springs, hoping to find a guide to accompany them to the Colorado River crossing. Their recruiting efforts were unsuccessful, however, and they were forced to proceed without one. After considerable hardships, they managed to find a route over the Kaibab Plateau via La Fevre Canyon (Reilly 1978:382). The expedition spent several days encamped in House Rock Valley before continuing eastward. It was during this leg of the journey that a new spring was discovered near the base of the Paria Plateau. Thales Haskell and two other members of the expedition "dug out and walled up this spring and named it Jacob's Pools" (Brooks 1944b:75). From this point, the party proceeded along the same route as the 1858 expedition, passing up the mouth of the Paria River and over the cliffs through Dominguez Pass to the Ute Ford.

On the third journey eastward in the fall of 1860, Hamblin resolved to bring a boat to the mouth of the Paria. The party managed to transport a boat over the Kaibab as far as House Rock Valley before the wagon that was carrying it became hopelessly mired in drifting sand and had to be abandoned at Jacob's Pools. En route, the expedition's Paiute guide, Enoch, introduced the Mormons to House Rock Springs (Reilly 1978:384). The party proceeded on to the mouth of the Paria where they constructed a small raft of driftwood. One group managed to reach the other shore, but only barely, so Hamblin decided to abandon his original plan and continue on to the Ute Ford. The decision proved fatal, for a few days after crossing the river, still en route to the Hopi villages, the party was ambushed by Navajos. One member of the party, George A. Smith Jr., was mortally wounded. In their hasty retreat, the Mormons were forced to abandon Smith's body along the trail. Later that winter, Hamblin and several others recrossed the river at the Ute Ford and retrieved Smith's remains. Following this unpleasant episode, this route to the Hopi villages was not used again for several years.

In 1862, Hamblin received instructions from Brigham Young to find an alternate route to the Hopi country that would bypass the hostile Navajos living south of the Ute Ford. Hamblin set out from St. George in October 1862 with twenty men and a small boat, heading south towards the Colorado River. His route apparently led through Dinner Flats, up Black Rock Gulch to Bentley Pass, then down Ide Valley to Grand Wash and along the wash to the river. A successful crossing was made about a mile upstream from the mouth of Grand Wash (Crampton 1965:119). After proceeding overland through the San Francisco Mountains region to the Hopi villages, the party returned by way of the Ute Ford, thereby completing the first circumnavigation of the Grand Canyon.

Hamblin undertook another journey to the Hopis in the fall of the following year. This time he was instructed to locate a route for a wagon road with watering places and pasturage and establish a ferry at the crossing (Corbett 1952:217). Because high cliffs opposite the mouth of Grand Wash had caused difficulties the previous year, Hamblin selected another crossing point on the river approximately five miles upstream from the previous one. According to Smith (1972:379):

> Access to the new crossing from the north was up Pigeon Wash to Snap Canyon, down it several miles, then east across the ridge into Pearce Wash and up along the river to the crossing. This site allowed a smooth crossing and an easy ascent from the river up Grapevine Wash. This was the first recorded use of the crossing later known as Pierce's Ferry.

Pioneering Settlements on the Arizona Strip

Largely as a result of Hamblin's trail blazing efforts, the geography of the northern and western margins of the Arizona Strip had become less of an enigma to the settlers in southern Utah by the early 1860s. At this time, there was one principal trail across the Arizona Strip that led southeast from Santa

Clara and the newly established community of St. George to the "Hurricane Hill" south of Toquerville, surmounted the Hurricane Cliffs and continued past Gould's Ranch and the Sheep Troughs to the vicinity of Short Creek, then ran along the base of the Vermilion Cliffs past Pipe Springs and Kanab Creek to the foot of the Kaibab Plateau. The trail then passed eastward over the Buckskin Mountain via Jacob or LaFevre Canyon and down Trail Canyon to House Rock Valley (Reilly 1978). From here, it continued along the base of the Paria Plateau to the future site of Lee's Ferry. Although infrequently traveled at this time, this trail opened the way for future settlement of the area, and it was along this corridor that the first settlers established themselves.

Initial occupation of the Arizona Strip represented a direct extension of Mormon settlement in southwestern Utah. Even though the Compromise of 1850 had drawn an arbitrary line separating Utah from Arizona (then New Mexico Territory), the newly drawn political boundary had little significance. The isolation sought by the Mormons in the Salt Lake Valley was duplicated on the Arizona Strip. Here they were totally protected from intruders by the canyon of the Colorado River on the east and south, by the desert to the west, and by their own people to the north.

The paucity of live streams in this region precluded the establishment of Mormon farming settlements based on communally operated irrigation systems, as advocated by Brigham Young. In the mid-nineteenth century, only one area on the Arizona Strip offered the right combination of arable land and a controllable supply of flowing water sufficient to support a substantial agricultural community: the right bank terrace of the Virgin River below The Narrows at the junction with Beaver Dam Creek. In the early 1880s, a flood swept down Kanab Canyon and removed accumulated sediments in the wash bottom, thereby increasing the volume of flowing surface water. This natural catastrophe created new opportunities for farming below the Shinarump Cliffs. In due time, both of these areas would be occupied by Mormon farming communities. Initially, however, settlement of the Strip country was carried out by self-motiviated individuals, rather than by church-organized colonies. These pioneers established ranching outposts, and later, lumber mills, to serve the growing settlements in southern Utah.

The first attempted Mormon settlement on the Arizona Strip was on Short Creek, a short distance upstream from the present community of Colorado City. Sometime in 1862, William B. Maxwell established a ranch at this location. Although there is little information concerning this initial settlement, we know that he was definitely in residence there by January 1863 when Hamblin and several missionaries passed through the area on their return from their third visit with the Hopis (Little 1881:79).

Pipe Springs, located 8 miles south of the Utah border and about 11 miles west of Kanab Creek, was the next site to be developed. In early April 1863, Dr. James Whitmore, a recent arrival to St. George, submitted a request to officials of Washington County, Utah, for a land certificate entitling him to a 160-acre townsite surrounding the springs (Lavender 1984:5). At this time, Pipe Springs was thought to lie within the bounds of Utah Territory. Whitmore and his relative, Robert McIntyre (variously described as son-in-law, brother-in-law, or stepson), built a dugout at the Springs, and this became their ranch headquarters (Bradley 1960).

Moccasin Springs, four miles north of Pipe Springs, was claimed by William B. Maxwell that same year (Robinson 1970:481). Maxwell used the springs to water his stock, but did not establish any dwellings there. The following year, Maxwell sold his Moccasin claim to a man named Rhodes. Rhodes and two brothers named Randall and Woodruff Alexander established a ranch at the springs in 1864.

Meanwhile, on the west side of the Strip, the town of Millersburg was founded in 1864 by Henry W. Miller who had been called to settle there in 1863 (McClintock 1985:117). The settlement, which later changed its name to Beaver Dams on account of the industrious rodent population that repeatedly blocked the irrigation ditches, was located on the west bank of the Virgin River near the mouth of Beaver Dam Creek, seven miles east of the Nevada border and six miles south of the Utah border on the Mormon road to California (Larson 1961:166-167). Six miles below the point where the river emerges from The Narrows, a tract of land was cleared, and by 1864 crops had been planted. A year later, the town boasted of fruit orchards, vineyards, and wheat fields. These successes were short-lived, however, for the area was flooded in 1867, and not resettled until 1875 (Wilson 1941:51-52).

In early January, 1866, Whitmore and McIntyre were killed by Indian raiders. The murders precipitated a series of hostile encounters between the Mormons and local Indians, which culminated in the Mormons' withdrawal from the entire region between the Paria and Colorado rivers as far west as the Hurricane Cliffs. For the next four years, the Arizona Strip served as strategic buffer zone and occasional battleground separating the established settlers in Dixie from their hostile neighbors to the southeast.

The Black Hawk Navajo Wars, 1866-1869

Cut off from the main trade routes and lacking abundant fur resources, the Southern Paiutes had few means for acquiring guns and ammunition with which to protect themselves from the relentless slave raiding carried out by their Ute neighbors during the mid-nineteenth century. Thus, when Mormon settlers began moving in from the north, Paiutes initially welcomed their presence in the area (Brown 1941:110). The Paiutes viewed the settlers as potential buffers against their Ute enemies and as sources for the technology that had previously been unavailable to them (Alley 1982:123).

The benefits of the Mormon presence in southern Utah and the Arizona Strip were soon offset by negative consequences. The rapid establishment of Mormon settlements throughout southern Utah and at Pipe Springs, Moccassin, and Short Creek on the Arizona Strip displaced the Southern Paiute from the most optimal areas of their traditional territorial range. The expansion of cattle herds on the grasslands south of the Vermilion Cliffs further reduced the aboriginal subsistence base. Faced with the prospect of starvation, some Paiutes resorted to killing Mormon livestock, and others moved to the outskirts of the Mormon settlements to exchange labor for food, or sometimes simply to beg.

The Mormon presence on the frontier and periodic hostile encounters with non-Mormon prospectors and trappers fostered the development of new alliances between the Paiutes and their traditional adversaries, the Navajos. Alliances with the Navajo may have been encouraged by members of the San Juan Paiute band on the east side of the river, who maintained close contacts with both groups. For the most part, these alliances between Kaibab Paiutes and Navajos were short-lived, since the Navajos had the most to gain from the relationship, while the Paiutes bore the brunt of the Mormons' aggressive retaliation. Although some Paiutes, such as the infamous renegade Patnish (Robinson 1970:10, 31-34), perpetuated a long-term adversarial relationship with the Mormons, the majority of Southern Paiutes on the Arizona Strip threw in their lot with the Mormons shortly after Mormons began their retaliatory moves against the raiders.

During the early 1860s, the Mormon settlements in southern Utah were increasingly plagued by raids from Utes and Navajos, as well as by local Paiutes. In 1865, a growing unrest among the Ute bands in Sevier Valley of central Utah erupted into violent confrontation. The Black Hawk War, as it came to be known, was ignited by a series of coordinated attacks on Mormon livestock. In part, these depredations on the Mormon settlements may have been fostered by the dissolution of the lucrative Spanish slave trade. With Paiute slaves no longer a profitable commodity, the mounted raiders shifted their focus to livestock, principally horses. The Utes, like their enemies, the Navajo, desired horses for mobility, prestige, and as items for exchange, and the isolated homesteads and fledgling settlements scattered along the southern Mormon frontier provided a ready supply. Ute successes in central Utah apparently encouraged some of the Indians living along the Arizona-Utah border to undertake their own livestock raids against outlying Mormon settlements or to participate in raids organized by their aggressive Navajo neighbors, and the settlers in southern Utah soon found themselves in a state of seige (Woodbury 1944:167-168).

Although the following four years of Indian hostility (1866- 1869) on the Arizona Strip are sometimes treated as a southern phase of the Black Hawk War (e.g. Robinson 1970:8), it is more accurate to consider them as a western extension of the ongoing "Navajo wars" in northeastern Arizona. It was primarily Navajos from the east side of the Colorado River who instigated the attacks in southern Utah, while the Utes concentrated their efforts farther to the north. A primary factor that encouraged the Navajo to focus their raiding efforts on the Mormon settlements west of the Colorado River was the mounting pressure from American military forces in the east. As the New Mexican front advanced, the Navajo withdrew to the west. Several Navajo bands sought refuge in the rugged canyon country north and east of Navajo Mountain. This territory was occupied by Paiutes when Dominguez and Escalante passed through the region in 1776, and although it was still considered Paiute territory when American military expeditions made their first forays into northeastern Arizona (Bailey 1964:89), it came increasingly under Navajo control during the 1850s. This rough and dissected country immediately opposite the Crossing of the Fathers provided an ideal staging area for raids across the river.

After Whitmore and McIntyre were murdered near Pipe Springs, men from the settlements along the Virgin River quickly organized themselves as a company of the Utah Territorial Militia and returned to the area in pursuit of the raiders. The tracks of the raiders had been covered by snow, but they soon picked up other tracks and eventually surprised two Paiutes who were in the process of butchering a steer. The two Paiutes were taken to Pipe Springs, where they were tortured. Under duress, the Paiutes lead their captors to a camp on Kanab Creek. At sunrise on January 20, the militia attacked the camp, killing two Indians and capturing five others, some of whom had property belonging to the deceased ranchers in their possession. Despite protestations from the Paiutes, who claimed to have obtained these items in trade from some visiting Navajos, the captives were promptly executed (Olsen 1966).

To forestall further attacks on livestock, Erastus Snow, President of the St. George Stake, ordered the settlers along the southern frontier to round up the herds grazing on the Arizona Strip and move them nearer to settlements in Dixie. Although grazing was poor near the settlements and the mountains to the northwest were already filled to capacity, the settlers reluctantly complied. In April, a band of men who were rounding up livestock near Maxwells' ranch on Short Creek came across the bodies of Robert and Joe Berry, and Robert's pregnant wife, Isabel. Although the culprits were never caught, it was generally assumed that Paiutes had carried out the murders in retaliation for the killing of their five band members earlier that year (Woodbury 1944:170). The atrocity reputely took place just south of the Arizona-Utah border, at a location due south of Colorado City now known as Berry Knolls (Crampton 1965:126). Shortly after word of the Berry murders reached St. George, Mormon leaders imposed martial law. On May 2, 1866, President Snow ordered the settlers to concentrate in fortified locations with at least 150 men (Woodbury 1949:169-170). This order ultimately resulted in the evacuation of all settlements east of the Hurricane Cliffs.

Jacob Hamblin was instrumental in averting further confrontations between the Paiutes and Mormon settlers during this period (Little 1881). Being versed in the native language and endowed with the ability to persuade and compromise, he was able to win the trust of many Paiutes. The majority of the Kaibab Paiutes agreed to work with the Mormons and help defend the region from outside raiders. Bands of friendly Paiutes remained stationed at the hastily abandoned settlements, tending the fields and serving as advance lookouts for the communities farther west. In exchange, the Paiutes received food as well as protection from Navajo and Ute retalitations (Malach 1981:15).

The Shivwits Paiutes were somewhat less co-operative with the Mormons. Their position on the southwestern corner of the Strip, in proximity to the Kingman and Las Vegas mining camps, may have heightened their ambivalence towards white men in general. An alliance between the Shivwits Paiutes and Walapais apparently developed during this period, perhaps in response to the mutual threat from incursions of Anglo prospectors and trappers into the western Grand Canyon region at this time. In the late 1860s, threatened by the mounting hostility of the Mormons, who in turn were angered by Paiute depredations on cattle herds grazing on the Arizona Strip, a band of Shivwits Indians took refuge with the Pine Spring Band of Walapais on the south side of the river (Spier 1928:360; Dobyns and Euler 1980). The lack of precedence for an alliance between the Shivwits band and the Walapai is substantiated by ethnographic accounts relating to this period (e.g., Spier 1928:360).

On November 29, 1886, General Snow issued an order to establish guard posts at strtegic locations around St. George. He specified that the structures were "to be covered with stone flagging or earth in a manner that it can not be fired from the outside, with one door and that heavy and strongly barred, so that one or two men, well armed, may defend themselves against any number of Indians" (Woodbury 1944:173). One guàrd station was constructed at Berry Spring, while another one was constructed in the Warner Valley southeast of St. George. The men stationed at Fort Pierce, as the latter post was called, served double duty as herdsmen for the livestock that had been driven into this area from the abandoned grazing lands farther east.

Other guard posts were established along the major trails leading to the settlements in Dixie. One of the first sites selected for this purpose was Pipe Springs. This site offered an ideal setting for a guard station, since the gorge of Kanab Creek a few miles to the south and the sheer Vermilion Cliffs to the north effectively funneled all the traffic on the Strip past this point. Although never used as a permanent garrison, Pipe Springs was a favorite rendezvous point for the militia forces throughout the late 1860s. In 1868, the militiamen built a small one room stone building east of the Whitmore dugout for storage and shelter. The only fighting that occurred near Pipe Springs took place late in 1869, when the militia engaged a large party of Navajos returning from a raid in the Cedar City area. As was typical of most military encounters during this "war," this skirmish resulted in several Indian casualities and the recovery of some stolen stock, but a number of the raiders managed to escape across the Colorado River (Woodbury 1944:173-174).

The ranch at Moccasin also served as a base camp for companies of the Utah Territorial Militia during their periodic campaigns against Navajo and Paiute raiders (Crampton and Miller 1961). Other guard posts were established on the trails leading to the Ute Ford, where the raiders were most likely to drive the stock across the river. The crossing at the mouth of the Paria, although impractical during much of the year, was occasionally used by the Indians during late fall and winter, when the water flow was lowest, and it became more heavily used by raiding parties as the Mormons increased their vigilance along the trails leading to Ute Ford. In the winter of 1869, the site was apparently guarded by several men from the Southern Utah Militia, and a shelter was constructed against a high rock wall quite close to Dominguez and Escalante's 1776 campsite (Rusho and Crampton 1981:18). Walter Clement Powell, a member of the 1871 1872 Powell expedition, apparently refers to this guard station in a journal entry dated October 23, 1871 (Kelly 1948-1949:356).

> Just back of camp and against the cliff is an old house made of straw, sticks, and stones, and on the cliff is the remains of the old fort. This place and the Crossing of the Fathers above, used to be the crossing where the Navajos used to drive stolen stock and sheep from the Mormons to their country. A lot of Navajos came over a few years ago and drove off a flock of 600 sheep, drove them down here, waited till the river was frozen and crossed them over on the ice. . . . Since, [the Mormons] have kept a guard of men at each place to intercept the Indians on their raids, but last year they succeeded in making a treaty with them and the guards were discontinued.

The "treaty" Powell refers to was an informal agreement negotiated by Jacob Hamblin with the Navajos in November 1870 during the annual reunion of the tribe at Fort Defiance. Accompanied by John Wesley Powell, who was visiting the region in preparation for his second voyage down the Colorado, Hamblin had journeyed to Fort Defiance where the Navajos were gathering to receive their government issued annuities. At Hamblin's behest or perhaps of his own volition, Powell presented himself to the Navajos as an official representative of the U.S. government, reminded them of their recent incarceration at Fort Defiance, and warned them of the likelihood of further punishment if they did not cease raiding the settlements across the river. With this impressive show of support, Hamblin was eventually successful in establishing peace between the Navajos and Mormons. Although sporadic raids continued during the following two years, this unofficial "Treaty of Fort Defiance" opened the way for an extended period of peaceful trade between the Navajos, Paiutes, and Mormons.

Mormon Expansion and the Opening of Major Wagon Roads: 1870-1885

One of the major outcomes of the Mormon Navajo wars was that a large portion of the country east and south of Kanab Creek was explored for the first time. In the course of pursuing raiders, the Utah militiaman traced out most, if not all, of the main horse trails across the Arizona Strip as well as a number of secondary routes. They crossed the Kaibab Plateau on several occasions, found a northern trail to the Ute Ford that bypassed the lower Paria River, and also discovered a number of new water holes. By the time settlers began drifting back into the region in the late 1860s, knowledge of the Arizona Strip topography had improved considerably. Nevertheless, there were still large tracts of land, particularly along the southern margins of the Strip, that remained unexplored.

In the spring of 1870, Brigham Young issued a call to resettle Kanab and the surrounding area. Many of the original pioneers who had been forced from their homes in 1866 now returned, and in addition, a large contingent of Mormons from colonies along the Muddy River moved into the area at this time. Both of these groups had taken refuge in the Dixie country surrounding St. George during the late 1860s and responded eagerly to the opportunity of establishing permanent homes once again.

The move to Kanab involved a four or five day trip by wagon along the route previously pioneered by Jacob Hamblin (Figure 45). The main road led eastward out of St. George to the base of the Hurricane Cliffs, up a steep ridge to the neighborhood of Workman Spring (later known as Gould's Ranch) and then westward to Canaan Spring. From here the road bent southeastward, following the base of the Vermilion Cliffs past Short Creek to Pipe Springs. The road then swung northeastward up to Moccasin Springs, then continued on a northeastern heading to Kanab.

Concurrent with the resettlement of Kanab, there was a growing sentiment among non-Mormon officials in the Utah governor's office that the LDS Church held too much sway over the civic affairs in the territory. Symbolic of this situation was the fact that none of the Mormons involved in the infamous 1857 massacre of California-bound emigrants at Mountain Meadows had ever been brought to trial, despite the fact that several of the participants were well known to church officials and the populace at large. John D. Lee, a zealous adherent of the Mormon faith and a loyal friend of Brigham Young, was one of the key participants in this notorious event. As the campaign to bring the perpetrators of the massacre to trial gradually gained momentum, Lee's name rose to prominence on the list of wanted men.

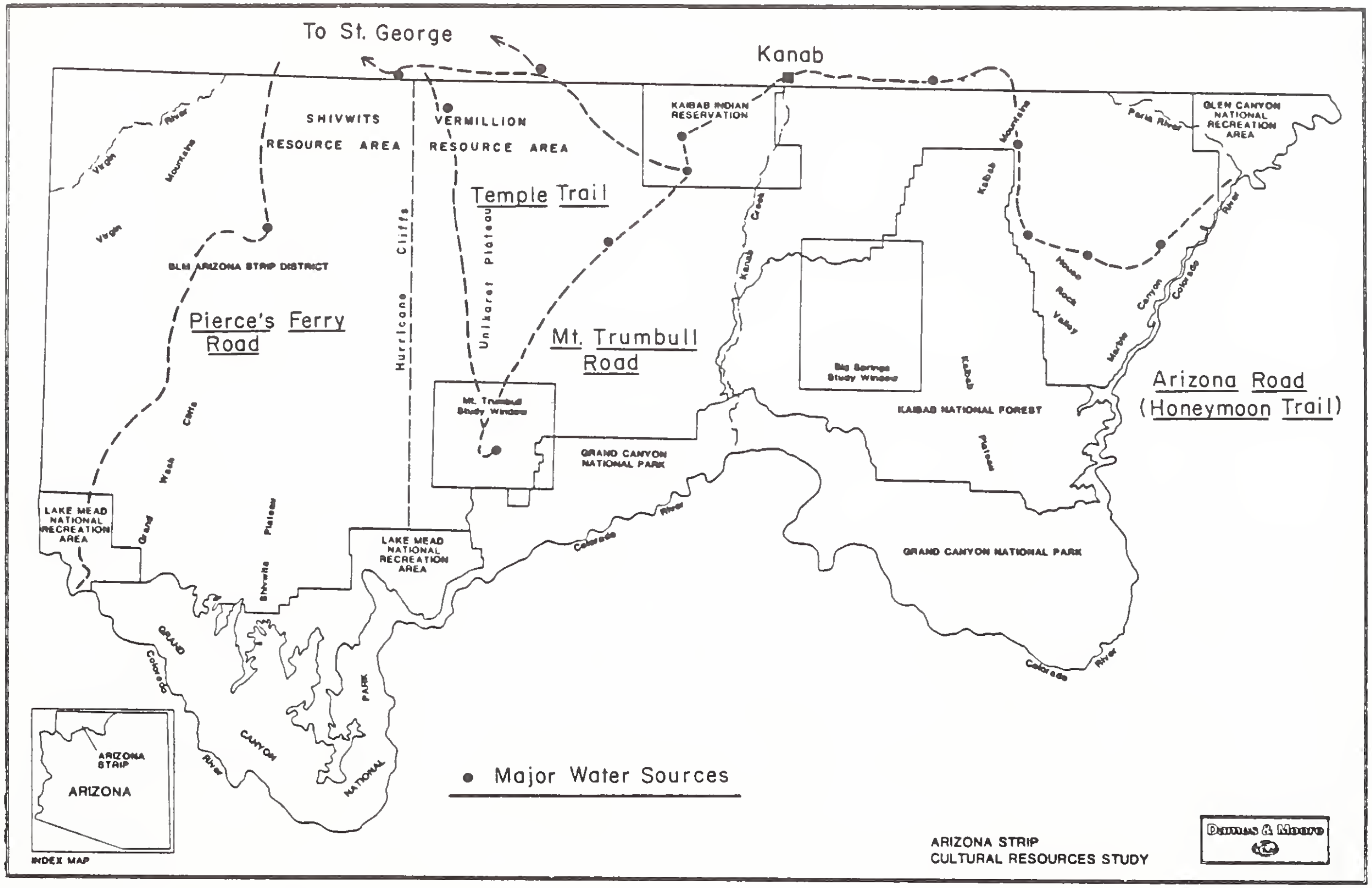


Figure 45. Major Wagon Roads on the Arizona Strip in 1880.

In September, 1870, while on a visit to consecrate the newly re-established settlement at Kanab, Brigham Young advised Lee to move into the hills northeast of Kanab. There he would be safe from federal marshals, and at the same time, could provide a much needed service to the Church and the people of Kanab by running a sawmill to provide lumber for the planned construction at Pipe Springs and the growing community at Kanab. Young offered to set Lee up in a partnership with Levi Stewart, the newly ordained Bishop of Kanab, if Lee would operate the mill on a share basis with the Church. Lee agreed, but the arrangement did not last long. Repeated breakdowns of the machinery and ongoing conflicts with Stewart's hired labor convinced Lee to divest himself of the mill in January 1871. Lee sold his mill rights to Bishop Stewart's son, John, who promptly moved it to the west flank of the Kaibab Plateau near Big Springs (Cleland and Brooks 1983:158-159).

Shortly thereafter, Lee learned that the federal government had mounted an intensive campaign against polygamists. Lee, with his 17 wives, was a principal target of this campaign. Having recently been excommunicated by the Church over his involvement in the Mountain Meadows massacre and uncertain about his future, Lee sought advice from his old friend, Jacob Hamblin. Lee's diary entry of November 15, 1871 recounts the substance of that meeting (Cleland and Brooks 1983:175-176).

> I had a Private interview with J. Hamblin He gave me the pass word to Make my way to the Lonely Dell by way of the Hogon wells, & Join a company & make a road to the Crossing of the Colorado River near that point. [He said] there is a good place for setlement & you are invited to take it up & occupy it with as Many good Ranches as you want & can secur [sic]. . . So if you have a woman that has Faith enough to go, take her along & some cows.

This diary entry brings out a number of historically significant points. First, it demonstrates that the name Lonely Dell was not coined by Lee's wife, Emma, as many historical accounts suggest (e.g., Brooks 1957:283; Measles 1981; Rusho and Crampton 1981:32), since Emma had not yet laid eyes on the Paria crossing when Lee first used the phrase. It also reveals that the LDS Church was at least indirectly involved in constructing the first wagon road across the Kaibab to the mouth of the Paria. Finally, it exemplifies the prevalent method by which claims to water and ranching areas were established by the early Mormon settlers, that is by simple appropriation and occupation. Many years later, when non-Mormon ranchers entered the area, this informal approach to establishing land and water rights caused considerable difficulties for the original Mormon occupants of the Strip.

Hamblin's advice to Lee was not entirely altruistic. Hamblin was interested in establishing claims to the area, but his other obligations as Indian agent and emmissary for the Church prevented him from doing so. At the same time, the Church had a strong motivation for seeing the ferry site claimed by a loyal Mormon such as Lee. Despite mounting opposition from the federal government and Utah legislators vis-a-vis the expansion of Mormon influence in the region, Brigham Young's State of Deseret concept was still very much alive in the minds of LDS Church officials eager to expand their dominion south of the Colorado River. Successful implementation of this plan required that the church first secure claim to the region leading to the crossing at Paria, as well as control of the crossing itself. John D. Lee was in the perfect position to accomplish these ends.

Whatever Hamblin's ultimate motivations might have been in suggesting the move to Lonely Dell, Lee was quick to act on his advice. In late November 1871 Lee set out from Skutumpah with 60 cattle and 3 wagons. Lee met up with a road construction crew from Kanab at Navajo Wells, a major stopping place on the wagon track between Kanab and Pahreah, about 14 miles east of Kanab. From this point there was a well beaten horse path that ran southeast from the Wells to the foot of the Kaibab Plateau, then climbed gradually but steadily southward and passed through Summit Valley, before turning eastward and dropping down a steep, open slope into the head of House Rock Valley. The trail then cut southeastward across the open valley to House Rock Spring, skirted the base of the

Paria Plateau by way of Jacob Pools, Soap Creek, and Badger Creek, before dropping down to the bank of the Colorado River a short distance above the mouth of the Paria River (Reilly 1978:388).

This trail was not suitable for wagons, however, due to the rocky terrain and steep grades. Since the road building crew was opposed to keeping company with Lee's cattle, Lee decided to push on to Pahreah and drive the herd down to the Colorado River by way of Pahreah Canyon. His three wives were instructed to bring the wagons around to the ferry site on the road then under construction. When Lee arrived at the mouth of the Paria on December 2, 1871, having endured a grueling cattle drive down through the Paria River gorge, there were no signs of his wives or wagons. Lee back tracked to Kanab and learned that the women had turned back when the new "road" proved impassable for the teams and wagons. Lee convinced one wife, Emma, to return with him, and after much hard labor, the two of them succeeded in bringing the first wheeled vehicles all the way to Lee's Ferry.

The new wagon road over the Kaibab Plateau diverged from the Kanab-Pahreah wagon track about seven miles east of Navajo Wells and ascended a wide open slope at the north end of the plateau, first in a southeasterly direction and then due south. After climbing gradually for approximately 10 miles, the road turned eastward and descended into Coyote Valley, then swung southward again to cross over the divide into House Rock Valley (Reilly 1978:389). Although considerably longer than the horse trail, this route had the advantage of having gentler grades; however, the new road was extremely rough, and as noted by Almon H. Thompson in his diary entry of January 18, 1872 (Gregory 1939), the little advantage gained from the easier topography was more than offset by the increased distance. Nevertheless, it was several years before a shorter wagon road was opened across the Kaibab Plateau.

A few days after arriving at Lonely Dell, Lee commenced his responsibilities as a ferry man by piloting 15 Navajos across the river in the flat-bottomed scow that Hamblin and some of John Wesley Powell's men had constructed the previous year. During the following months, most of the ferry traffic consisted of prospectors who flooded into the Strip after hearing of the gold discovery at the mouth of Kanab Creek. In mid-April 1872, while Lee was absent from the ferry, a group of miners commandeered the old scow with the intention of prospecting along the river below the ferry, but the boat was swamped in Badger Creek rapid and destroyed (Cleland and Brooks 1983:188). Lee was forced to ferry with one of Powell' skiffs for the remainder of the year.

In the autumn of 1872, Lee received notice that the church was preparing to send colonists to the Little Colorado region and was instructed to construct a new ferry that would be suitable for use by wagons. Lumber from John Stewart's mill at Big Springs arrived at the ferry site the following month, and on January 11, 1873, a new ferry boat was launched (Cleland and Brooks 1983:219). A dozen Mormon scouts under the command of Horton Haight and Jacob Hamblin, who were heading for the Little Colorado country to assess its suitability for settlement by the colonists, were the first to cross on the new ferry. The reconnaissance team was forced to leave their wagons at the mouth of the Paria, since suitable approach and exit roads to the ferry had not yet been constructed, but by the time the first colonists arrived at the ferry in late April 1873 a passable road was in place. Two wagons were ferried across on April 22 and by the following day, the first wagon train of Arizona colonists had crossed the river successfully and were headed on their way to the Little Colorado valley.

This first attempt at colonizing the Little Colorado area proved unsuccessful. Disheartened by the bleak landscape, the colonists abandoned the mission shortly after arriving at their destination. By early June, they were back at the ferry. One of the returning colonists commemorated the return of the first Arizona company with an inscription carved on a boulder by House Rock Spring: "Joseph Adams from Kaysville, to Arizona and busted on June 6 AD 1873" (Rusho and Crampton 1981:35). Although not the first one to mark his passage on the boulders surrounding House Rock Spring (John D. Lee had inscribed his name there in 1871), Adams' initiated a tradition perpetuated by many later Arizona-bound colonists, as well as some disheartened returnees. The extensive roster of names and dates chronicles the passage of many courageous and determined men, women, and children over this long and difficult wagon road that linked central Arizona with the communities north of the Colorado River.

The next attempt at colonizing the Little Colorado country did not occur until March 1876. By that time, Lee was no longer living at the ferry. In the summer of 1873, he had traded his ranch at Jacobs Pools and House Rock Spring to Jacob Hamblin in return for Hamblin's secluded ranch at Moenave, south of the Colorado River. Lee returned to the ferry occasionally during the following year, but most of the actual ferrying was carried out by an assistant. On November 7, 1874, while visiting family in Panguitch, Utah, Lee was apprehended by federal marshalls. His first trial in the summer of 1875 ended in a hung jury, but he was subsequently found guilty and executed on March 23, 1877 (Rusho and Crampton 1981:43-44). While Lee was awaiting trial, Church officials sent Warren M. Johnson to take over Lee's responsibilities at the Ferry. Johnson arrived at the Ferry in March 1875 and continued to serve as the ferryman for the following twenty years (Reilly 1971).

Concurrent with the development of Lee's Ferry, the LDS Church initiated construction of the temple at St. George. This ambitious building project commenced in the spring of 1871 and continued without a significant break for the next five years. Virtually the entire labor force of southern Utah and the Arizona Strip was involved in the project at one time or another. The massive amounts of lumber required for this project were procured from the forests around Mount Trumbull.

Before lumber could be brought to St. George, a road had to be constructed to the proposed millsite on the southern slopes of Mount Trumbull. Work on the Temple Trail commenced on April 13, 1874, and by May 16 a passable wagon road was in place (Larson 1961:586). The first USGS topographic quadrangles produced for the area, published in 1886 but based on field work conducted in the late 70s, show the approximate route of the Temple Trail. From the mill below Nixon Spring, the road curved around the western flank of Mount Trumbull, then headed on a straight course slightly west of north, paralleling the Hurricane Cliffs all the way to Antelope Springs. A short distance to the north of the Springs, the road swung west and descended steeply down the Hurricane Cliffs, then followed Fort Pearce Wash through Warner Valley and on to St. George.

After the mill operation got underway in the summer of 1874, teams of oxen were employed to transport the lumber to Antelope Springs, from which point it was hauled by mule train to St. George. According to Larson (1961:587), it was customary to stockpile the fresh boards from the Mount Trumbull sawmills at Antelope Springs during the summer months, then freight them the rest of the way to St. George during the winter months when snow blanketed the higher elevations. A one way trip to Antelope Springs took two days, and necessitated the use of water wagons to service the overnight camps made both coming and going. The last leg of the trip, although considerably shorter than the Mount Trumbull-Antelope stretch, tested the stamina of men and beasts alike. Larson (1961:587) describes the difficulties encountered by freighters on the steep descent through the Hurricane Cliffs. "Before assaying the steep descent, the drivers tightened the binding on the loads and then rough locked the rear wheels to act as a brake on the freighters' wagons. Even with rough lock, the heavily ladened running gears came down the hill too rapidly for comfort." Perhaps it was the feeling of relief at having survived the rigors of this descent that prompted Temple freighters and other early travelers to inscribe their names on the basalt rocks near the mouth of Black Rock Canyon.

Despite its logistical drawbacks, the Temple Trail provided a much needed access route into the heart of the Arizona Strip and opened the way for intensive exploitation of the Mount Trumbull region. Approximately one million board feet of lumber were hauled over the Temple Trail between the summer of 1874 and the winter of 1876, and many additional loads were freighted on this road after the spring of 1877, when the temple was completed and the Church owned mill was turned over to private ownership (see discussion on lumbering below).

In the spring of 1876, as temple construction approached its final year, the Church launched a second attempt to colonize the Little Colorado country. This time, the effort proved successful (Petersen 1967). Throughout the following year, most of the wagon traffic at Lee's Ferry flowed south towards the new settlements on the Little Colorado, but by the summer of 1878, a steady two-way traffic pattern had developed. A considerable portion of this two-way traffic consisted of newly married couples heading to or from the new temple at St. George. Church doctrine required the solemnization of all Mormon marriages in a temple ceremony, but until the first temple in Utah was dedicated at St. George in April, 1877, Mormon couples were unable to fulfill this sacred obligation. When the St. George temple opened its doors, a stream of newlyweds converged on the site. The dedication of the Salt Lake Temple in 1893 diverted some of the traffic, but St. George remained the primary destination for Arizona newlyweds until 1928, when the temple at Mesa, Arizona, was completed.

Although the undertaking of this obligatory pilgrimage required a major effort on the part of newlyweds living along the Little Colorado River, it was a once-in-a-lifetime experience that few young couples cared to miss. Typically, an expedition was organized in the late autumn by a group of couples who had been married by a local justice of the peace during the previous year. Caravans of canvas-topped wagons usually set out in early November, after crops had been harvested but before deep snows blanketed the Buckskin Mountain. Proceeding at a leisurely pace, they followed the well-defined but still rough road to Lee's Ferry, around the base of the Paria Plateau, past House Rock Springs and across the northern flank of the Kaibab Plateau to Kanab. The newlyweds often tarried for several days at Kanab or Pipe Springs, socializing with friends or family and stocking up on supplies, before making the final push to St. George. At Pipe Springs, there was a major fork in the road. One branch headed northwest along the Deseret Telegraph road past Cane Beds, Short Creek, the Canaan Ranch, Sheep Trough Spring and Workman's Spring (Gould's Ranch). At Gould's Ranch, this road forked again, one branch continuing northwest and descending Hurricane Hill to Toquerville, while the other branch continued west and dropped over the Hurricane Ledge to Berry Spring and St. George. The other main road ran southwest from Pipe Springs to Yellowstone Spring, then west along the southern base of Short Creek and Little Creek Mountain to where it intercepted the Temple Trail just above Hurricane Dugway. After negotiating the steep descent through the Hurricane Cliffs, the travelers emerged in an open valley near Fort Pierce Spring, then followed a relatively straight path up the valley to St. George. This latter road was the most direct route to St. George, and apparently the one most frequently traveled by the caravans of newlyweds.

To the people who traveled over it, the wagon road between Kanab and Lee's Ferry was simply known as "The Arizona Road" (Reilly 1978; Templeton 1979). This name presumably derived from the fact that this road ran mostly south of the Utah border and was used extensively by settlers traveling either to or from central Arizona. Many years later, in commemoration of its extensive use by Arizona newlyweds during the late 1870s and 1880s, this road and the southerly segment from Pipe Springs to Yellowstone Spring and down the Hurrican Dugway to St. George was nicknamed "The Honeymoon Trail" (Barnes 1934).

Due to limited water supplies, as well as the uneven distribution of fuel and forage, travelers tended to camp at the same locations along the Arizona Road. House Rock Springs was one of the most heavily used camp spots because it offered an ample supply of firewood and forage, in addition to its abundant, sweet-tasting water. It was a convenient place to prepare the wagons for the long haul over Buckskin Mountain, or to repair those that had been damaged on the eastward crossing. It was also a suitable place to recuperate from illnesses, or in some cases, to bury the dead. The grave of young May Whiting, who died at House Rock Spring on May 15, 1882, while her family was returning from Arizona, is there (Hooper and Hooper 1977a:19), and others are reportedly nearby (Templeton 1979). As previously noted, numerous nineteenth century inscriptions are carved on the sandstone boulders around the spring, providing a tangible record of the historic use of this location and the eastern segment of the Arizona Road.

Although the bulk of traffic heading for settlements on the Little Colorado traveled by way of Lee's Ferry, a few wagons trains went by way of Pierce's Ferry (Smith 1972). As noted previously, this crossing below the mouth of Grand Canyon was discovered by Jacob Hamblin in 1863. In 1873, Harrison Pearce, a citizen of St. George, was called by Church leaders to establish a ferry at the site. Ferry service did not actually get underway until 1877. Like Lee's Ferry, Pearce's Ferry (now officially misspelled Pierce's Ferry) was primarily developed for use by colonists bound for the Little Colorado country.

The general course of the wagon road to Pierce's Ferry was pioneered in 1868, five years prior to the arrrival of ferryman Pearce, by a group of St. George men under the leadership of Eratus Snow. Lts. Daniel W. Lockwood and D.A. Lyle of the Wheeler survey party traveled over it in 1871 (Belshaw and Peplow 1978:V-17). The road went south from St. George up through Black Rock Gulch to Black Rock Springs, around the north and west side of Mustang Knolls through Ide Valley, then down Black Canyon and Pocum Wash to the main stem of Grand Wash. The trail continued down Grand Wash to the junction with Pigeon Wash, then followed Pigeon to Tasi Wash. The trail then climbed out of the drainage onto a broad bench and proceeded south to Snap Canyon. It dropped down into Snap Canyon via a side branch, then crossed the wash and ascended another tributary wash just above the mouth of Snap Canyon before crossing over another bench into Pearce Wash, which was then followed to the junction with the Colorado River (Smith 1972:379; Belshaw and Peplow 1978:I-33).

In 1876, a group of St. George men were called to improve the road to the ferry. Smith (1972:24) reports that "some tithing script ($214.39) was expended on 'the Colorado Road' account during the winter of 1876. To whom this fund was paid remains a mystery, but apparently road work was done in the canyons leading onto the plateau south of St. George." The dugway on the west side of Quail Canyon was apparently constructed at this time. According to Harrison Pearce's grandson, Joseph Pearce, Shivwits Paiutes were involved in the road construction project (Belshaw and Peplow 1978:V-18).

In 1877, the first Arizona emigrants arrived at the ferry. The caravan of 10 wagons, 26 people, and a herd of livestock was led by Richard Bentley and Samuel Cunningham, both of whom had prior knowledge of the Grand Wash region (Smith 1972:387-389; see also the discussion on mining below). Bentley and Cunningham reconnoitered a potential route from the vicinity of their copper claims near Hidden Springs down through Pigeon Wash, but decided that the route was impassable for wagons. Many years later, however, a road was developed along this route for use by freight wagons servicing the Grand Gulch mine from St. Thomas (Belshaw and Peplow 1978:V-2 through V-12).

Even after the inception of Pearce's ferry service, the crossing was used only infrequently, since it was less direct and reliable than Lee's Ferry (Belshaw and Peplow 1978:V-14). Furthermore, for travelers who chose to take the roundabout path to the Little Colorado settlements, a more accessible and reliable service was provided at the Bonelli Ferry, which could be reached via the road through Beaver Dams and Bunkerville. The next major use of Pierce's Ferry did not occur until 1879, when another party of emigrants under the leadership of David Kimball passed through the region (Smith 1972:392). Sporadic use of the ferry continued until 1882, when Pearce asked to be relieved from duty. After the ferry service ended, the wagon trail saw occasional use by stockmen and sheepherders. Today the trail is largely obliterated, although portions of the old Mokiac dugway are still visible along the west wall of Quail Canyon (Belshaw and Peplow 1978:V-19).

Government Surveys on the Arizona Strip

The reopening and settlement of the Arizona Strip in the early 1870s overlapped with another event of great significance in the history of the region: John Wesley Powell's topographic survey of 1871-1873. The survey of the Arizona Strip was a direct outgrowth of Powell's earlier explorations on the Colorado River in the summer of 1869. On May 24, 1869, he and nine men had set out from Green River, Wyoming in four wooden boats with provisions sufficient to last several months. The primary objective of this journey was to map the course of the Colorado River to its confluence with the Virgin River; a secondary but nonetheless important goal was to elucidate the natural history of this previously unexplored region. Despite these scientific objectives, Powell was the only member of the expedition who could claim any training in the natural sciences, and he was mostly self-taught. Furthermore, despite its official-sounding title, the Rocky Mountain Scientific Expedition was supported entirely by private money. The only involvement on the part of the federal government consisted of a resolution passed by Congress allowing Powell to draw rations at cost from military outposts along the river. Actual funding for the project, which was conducted under the auspices of the Illinois Natural History Association, came from various scientific institutions and from the major's own pockets.

Progress of the Powell party was monitored in the major midwestern newpapers. In early July, rumors began circulating in the press that all but one member of the expedition had perished shortly after the departure. These stories were discounted two weeks later when the Chicago Tribune received letters from Powell and several members of the expedition that had been sent out from the Uintah Ute Agency, near the confluence of the Green and White rivers, at the end of June. After this brief flurry of communication, however, nothing more was heard of the expedition for several weeks. As mid-August approached with no further sign of the expedition, the rumor mill began grinding once again. Having taken a personal interest in Powell's exploratory voyage, Brigham Young sent word to settlers along the lower Virgin River (via the recently installed telegraph at St. George) instructing them to be on the lookout for signs of the missing men or their equipment (Powell 1961:286). When Powell's battered expedition finally arrived at the mouth of the Virgin River on August 30, 1869, they found three Mormon men from St. Thomas, Nevada, on hand to meet them.

Four boats and 10 men started on the expedition, but only 2 boats and 6 men completed it. One man hiked out at the Uintah Agency and one boat was lost in the rapids of Cataract Canyon. The remaining nine men endured tremendous hardships and deprivation as they fought their way down the uncharted course of the Colorado. On August 28, only two days from the mouth of the Virgin River, three members of the party -- William Dunn and two brothers, Seneca and O.G. Howland -- elected to leave the expedition. Convinced that they would perish in the rapids that lay before them, they opted to climb out on to the plateau and make their way overland to the Mormon settlements in southern Utah. The six remaining men piled into two boats, and after successfully navigating more treacherous rapids, finally reached calm water below the Grand Wash Cliffs.

Upon arriving at St. Thomas, Powell immediately inquired if there was any any word of the three men, but received a negative reply. The expedition disbanded unceremoniously at St. Thomas, with Powell and his brother turning north towards St. George, while the remainder of the party continued downriver. At Santa Clara and again at St. George, Powell inquired after the missing men, but no word of their whereabouts had been received at that time. Two days after departing St. George, word of their fate finally caught up with Powell: the Shivwits Paiutes had murdered the three men after mistaking them for some miners who had recently molested an Indian woman in the area (Powell 1961).

Despite the tragedy, Powell's triumphant emergence from the depths of Grand Canyon brought him instant fame and honor: the last great mystery of the west had been solved (Goetzmann 1966:551).

Although the trip was a success from an exploratory standpoint, the expedition's scientific accomplishments had fallen far short of original goals. The necessities of mere survival had pre-empted scientific gains. Moreover, much of the information gathered on the lower half of the trip had been lost when the Howlands and Dunn hiked out at Separation Canyon, inadvertantly carrying duplicate copies of some of the expedition records. Recognizing these deficiencies, Powell immediately set about making plans for a second expedition down the Colorado River.

Aided by his new celebrity status, Powell was finally successful in garnering governmental support in the form of a $10,000 Congressional appropriation "to conduct a geographical and topographical survey of the Colorado River of the west" (Stegner 1954:123). In so doing, the Powell expedition joined the ranks of three other major government sponsored surveys of the west: the United States Geological Survey of the Fortieth Parallel directed by Clarence King, the United States Geological and Geographical Survey of the Territories under the direction of Ferdinand Hayden, and George M. Wheeler's Geographical surveys west of the 100th Meridian.

To ensure the success of this second expedition, Powell had to resolve several logistical problems beforehand. The heavily ladened boats on the first trip had been unwieldly, and repeated upsets in the rapids had caused the loss of critical food supplies. To lighten the boats and ensure adequate supplies throughout the journey, Powell needed to locate a series of resupply points along the river. Only two approaches to the river were known to exist between the Gunnison Crossing in east central Utah and the mouth of the Virgin River at that time: one at the mouth of the Paria River and the other at the Crossing of the Fathers 30 miles upstream. Ideally, Powell needed to find routes to the mouth of the Dirty Devil River and one or two other points downstream from the Paria.

A second critical issue concerned the attitude of the Paiute Indians north of the Colorado River. The killings of Dunn and the Howland brothers demonstrated that the native inhabitants of this region were still uneasy about the presence of the white men in their territory. Powell needed to reassure the Paiutes that he would cause them no harm and elicit a guarantee for the safety of his expedition while traveling through their territory. In addition, Powell hoped to obtain a full accounting of the murder of his men, the reasons for which were still unclear to him.

With these goals in mind, Powell returned to Salt Lake City in mid August of 1870, where he sought the advice of Brigham Young concerning his planned overland reconnaisances. Young immediately recommended Jacob Hamblin as a guide and interpreter. Young simultaneously informed Powell that he and several church officials would be traveling south in a few days to consecrate the newly re-established settlement at Kanab, and invited the major and his two young assistants to accompany them. Due to this fortutious circumstance, Powell was indirectly involved in several events of historical import on the Arizona Strip. After witnessing the consecration of Kanab on September 10, Powell accompanied Young, Hamblin, and several local church dignitaries to Pipe Springs, where he watched Young and Anson Winsor pace out the perimeter of a planned fort and ranch headquarters later to be known as Winsor Castle (Lavender 1984:24). It was during this same visit that Young instructed John D. Lee to sell his assets at New Harmony and move to Skumtumpah, north of Kanab, to help establish a sawmill that would supply lumber for the fledgling settlement at Kanab and the planned construction project at Pipe Springs.

From Pipe Springs, Powell, Hamblin, Powell's two assistants, and two Kaibab Paiute guides set out for the Uinkaret Mountains. On September 16, they encountered an encampment of Paiutes at the base of Mount Trumbull, in the vicinity of Witches Pockets (Dellenbaugh 1984:187,251). The next day, the Uinkaret Paiutes sent a messenger to the Shivwits band, requesting their presence at a meeting with the two white men. While awaiting the band's arrival, Powell took advantage of the opportunity to learn about Southern Paiute culture, and also to gather information about possible routes into the Grand Canyon (Powell 1961:302-303). The Uinkaret Paiutes obligingly led him down one precipitous trail (via Whitmore Wash?) but failed to point out a much easier alternative down Parashont Wash, perhaps because they feared that the dissemination of information about access routes to the river would bring prospectors, local cattlemen, or other undesirables into their territory (Stegner 1954:130,ff).

The meeting with the Shivwits band went according to plan. Following an introduction by Hamblin, the major explained his itinerary and goals for the coming year and received assurances that his men would have safe passage through the territory in the future. Later on, Hamblin elicited details concerning the fate of the Dunn-Howland party. Apparently, one or more visiting Walapai Indians from south of the Colorado River had arrived at the Shivwits' camp shortly after the three men had been there. The visiting Indians had convinced the Paiutes that the white men were prospectors similar, if not identical, to the ones who had lately molested and murdered a Walapai woman across the river. They advised their hosts to kill the three men immediately "for if they found any mines in their country, it would bring great evil among them" (Little 1881:97). Although the Paiutes had initially assisted the boatmen by supplying them with food and directions to the Mormon settlements, the Shivwits later pursued and killed them in their sleep.

According to Dellenbaugh (1962:xii), the murders took place southeast of Mount Dellanbaugh at Ambush Pockets, and Dellenbaugh named them on this account; but the presence of a "Dunn" inscription on the top of Mount Dellenbaugh dated 1869 and the word "water" with an arrow pointing northward (Belshaw 1979a:416) suggests that the party had already passed Ambush Pockets before being accosted by the Paiutes. Belshaw (1979a:416) sides with local folklore in placing the site of the killings at Log Spring near the head of Parashont Wash.

Powell originally intended to spend the autumn of 1870 scouting out routes to supply points along the Colorado River, but when he learned that Hamblin was planning a journey to the Hopi villages and a meeting with the Navajos at Fort Defiance, he altered his plans. In late September, Powell and Hamblin departed from Kanab with a mule train carrying supplies and lumber that would be used to construct a raft at the mouth of the Paria. At the base of Buckskin Mountain, the major and Hamblin split off from the pack train and headed southward along the west flank of the Plateau to search out alternative routes into the Grand Canyon. Accompanied by a Kaibab Paiute, Chuarumpeak, they camped at Big Springs that evening. In his 1875 account of this trip, Powell (1961:328) noted that the region beyond Big Springs was unknown to Hamblin. Chuarumpeak led the men to Point Sublime and then to Point Imperial, where they were able to look down at the confluence of the Little Colorado River. If the Paiute knew of routes into the canyon (and one can assume that he did), he did not share this information with the others. After returning to Big Springs, the party struck out to the northeast and eventually met up with the supply train at Jacob's Pools. From there the whole party proceeded on to the Paria River, arriving there on September 30. During the next two days, while the raft was being constructed, Powell explored the Paria River upstream from its mouth. On October 2, the flat-bottomed raft was completed, and the party successfully ferried themselves across the river.

From this point, the party continued on to the Hopi villages and the historic meeting at Fort Defiance. Prior to parting company at Fort Defiance, Powell engaged Hamblin to find a route to the mouth of the Dirty Devil. Due to pressing obligations stemming from his recent appointment as United States Indian Agent for Utah, Hamblin was unable to fulfill this assignment (Lavender 1982:121). Thus when the second expedition departed from Green River on May 22, 1871, Powell was faced with some of the same logistical difficulties that had plagued his previous expedition.

Like the first expedition, Powell's second expedition was largely made up of his relatives and friends, few of whom had any formal training in scientific methods and none of whom had had previous experience navigating on the Colorado River. Only one member of the first expedition, Jack Sumner, was invited to participate in this second voyage, and at the last minute he was unable to join the group. In addition to Powell, the crew of the second expedition included Powell's brother-in-law, Almon H. Thompson, a botany professor from Illinois; Clement Powell, a first cousin; Stephen V. Jones, a schoolteacher and relative of Thompson; Frank Bishop, John F. Stewart, and Andy Hatton, all of whom were ex-army acquaintances of Powell; Frank Richardson, a Powell family friend; Frederick Dellenbaugh; a seventeen-year-old self-taught artist and distant relative of Thompson; E.O. Beaman, a professional photographer from New York; and Jack Hillers, a German-born teamster who Powell hired on at the last minute in Salt Lake City.

Although Powell was the acknowledged commander of this motley crew, most of the credit for the success of the expedition deservably belongs to his brother-in-law, Professor Thompson. Powell, by this time, had become involved in the Washington, D.C., political scene and was distracted by other obligations, not the least of which was ensuring that his expedition continued to be funded by Congress. Anticipating periodic absences, Powell delegated the topographic mapping responsibilities to Thompson at the outset, and on several different occasions, left Thompson in charge of the whole show.

The first of Powell's departures from the expedition occurred at the Uintah Agency. Concerned over complications in his wife's first pregnancy and by the fact that Hamblin had failed to establish a supply depot at the head of Glen Canyon, Powell assigned Thompson the uneviable task of guiding the novice crew down to the Gunnison Crossing. A month later, Powell rejoined the party, having failed once again to locate a route to the mouth of the Dirty Devil. Faced with a food shortage, the group hastened on to the Ute Crossing where they were met by a pack train that had been sent out from Kanab. At this point, Powell left the expedition once again to go to Salt Lake City, instructing Thompson to run the boats down to the mouth of the Paria. The Powell party, minus Powell, arrived at the Paria on October 23. As previously planned, they cached the boats and some unnecessary supplies, preparatory to moving to Kanab where they planned to spend the winter and spring continuing their topographic survey of the Plateau province from a basecamp near Kanab.

On November 6, after an extended delay caused by a lost pack mule driver who was supposed to transport their gear to Kanab, the expedition finally departed from the Paria. Powell still had not returned from Salt Lake City, so Thompson instructed the men to establish themselves in a temporary camp at House Rock Spring, while he went on to Kanab to check on the Major's whereabouts and attend to two members of the expedition who had fallen ill. Dellenbaugh and three companions remained encamped at the spring for a month (Dellenbaugh 1984:157-164). After Powell finally returned in early December, the expedition regrouped in the vinicity of Kanab. A basecamp at Eight Mile Spring (on the Arizona Utah border eight miles east southeast of Kanab) was soon abandoned in favor of one located about six miles south of Kanab "at a point about a mile below the 'Gap' on Kanab Wash" (Gregory 1939:64). This site continued to serve as the primary base camp of the Powell expedition throughout the following year. Temporary base camps were later established at Pipe Springs and near St. George, Utah.

On December 14, Thompson initiated the first phase of the topographic survey by establishing, through astronomical observations, the longitude and latitude of a fixed point near the Kanab Gap base camp. This station served as the mid point for a nine-mile-long baseline that was subsequently surveyed southward as far as the red hills east of the present day townsite of Fredonia and northward to a point a short distance outside Kanab (Olsen 1969:265). The baseline survey was completed on February 21 (Gregory 1939:69). In the course of surveying the baseline, the exact location of the thirty-seventh parallel, marking the Arizona-Utah boundary, was determined for the first time.

The establishment of a baseline allowed the surveyors to accurately locate prominent topographic features throughout the surrounding countryside using the geometric principles of triangulation, that is, having established the length of one side of a triangle and knowing two of its angles, the surveyors could project the length of the remaining two sides and thereby establish the distances between various transit stations. Once the distance between two triangulation points had been calculated, the measured line functioned as a secondary baseline and allowed the system of triangles to be farther extended.

During the following six months, the surveyors roamed extensively over the Arizona Strip, expanding the system of triangles to the Uinkaret Mountains, south to the Colorado River, north to the White Cliffs in Utah, and east beyond the Paria River as far as the Dirty Devil River. In the course of this work, 12 triangulation stations were established at various locations on the Arizona Strip (Gannett 1894). These stations were marked either with large cairns, by stripping limbs off prominent pine trees, or by carving marks in nearby rock outcrops (Gannett 1894:397 401). Many of these station markers have been destroyed during the past century (Olsen 1969; Schiowitz 1984), but at least one marker, the Brow Monument, has been recently documented on the western flank of the Kaibab Plateau (Cleeland 1987a).

Even before the baseline was completed, Powell took leave from his topographers once more, this time to seek additional funding for the project in Washington, D.C. Before departing, however, he engaged John Stewart of Kanab to help him locate another supply point at the mouth of Kanab Canyon (locally known in those day as "Grand Gulch"). Accompanied by two prospectors named Bonnemont and Riley, Powell and Stewart succeeded in blazing a new trail to the banks of the Colorado. In the course of this journey, Bonnemont and Riley discovered flour gold in the sands of the Colorado, sparking off a short but intense gold rush (see discussion on mining below).

In August 1872 Powell finally rejoined his men at the mouth of the Paria River to continue the journey along the Colorado River. The expedition proceeded without mishap, despite the fact that the river was running high, necessitating frequent and difficult portages around the rapids. Two weeks later, the boats arrived at the mouth of Kanab Creek, where a supply train was on hand to meet them. Hamblin sent word with the packers that the Shivwits Paiutes were threatening to ambush his party downstream. This news, coupled with the high water levels, discouraged Powell from preceeding on. With the full consent of his men, Powell opted to cut the trip short and leave the river by way of Kanab Canyon.

By September 11, the Powell party was back in Kanab, preparing for the the last phase of the survey. This involved revisiting mapping stations on the Paria, Kaibab, and Uinkaret plateaus, as well as conducting a reconnaissance of the Shivwits region. The final step involved establishing an astronomic station on the north end of the Kanab baseline and exchanging time signals with the observatory at Salt Lake City in order to relate Kanab and the surrounding territory to the rest of the United States. This crucial last step, which required the aid of a telegraph, had been left to last because the Deseret Telegraph line had not yet been extended from St. George to Kanab when Thompson and his crew initiated their mapping project.

The Deseret Telegraph provided a critical link between Salt Lake City and the southern Utah colonies. Recognizing its strategic importance to furthering communiciation between the various settlements in the region and in protecting polygamists from prosecution by providing advance warning of federal marshalls' activities in outlying areas, Brigham Young had pushed hard for rapid installation of the line. The telegraph wires had reached St. George in 1869, and by early December, 1871, the line had been extended to Pipe Springs (Lavender 1984:28-29). (After Thompson's survey established that Pipe Springs lay within the state of Arizona, the site was recognized as the first telegraph station to operate in the state of Arizona [McClintock 1985:99]). Despite the rapid installation of the line up to this point, a shortage of funding and manpower brought on in part by the start of construction on the Mormon temple in St. George stalled completion of the last leg of the telegraph line to Kanab.

When Powell returned from the river in mid September and learned that the line had still not been completed, he immediately set off for Salt Lake City to inquire about the delay. Powell's trip to Salt Lake City apparently brought about the desired end, for by December 1872 the telegraph at Kanab was in operation and time signals were successfully exchanged. In a tent set up in Jacob Hamblin's back yard in Kanab, Dellenbaugh and Thompson put the finishing touches on the map, and in January, 1873, the prize product of the Powell survey was sent on its way to Washington, D.C.

Concurrent with the explorations of the second Powell expedition, another group of government surveyors had expanded their mapping project into the same territory. In 1871, the U.S. Army Corps of Topographical Engineers, in an attempt to preserve its reputation as the pre-eminent mapper of the western territories, assigned Lt. George M. Wheeler to conduct a far ranging topographical survey of the entire region lying west of the 100th meridian. One of Wheeler's field parties first entered the Arizona Strip region in the autumn of 1871. A detachment under the command of Lt. Daniel Lockwood passed through the St. Thomas Gap and traveled by way of Pakoon to St. George. On their return to the lower Colorado River, Lockwood's party retraced Hamblin's 1863 route down Grand Wash to the crossing at the future site of Pearce's Ferry (Belshaw and Peplow 1978). This was only the first of several times that the territories of the Powell and Wheeler surveys would overlap.

In late November 1872, just as Almon Thompson was completing his survey of the Shivwits Plateau, a Wheeler field party under the command of Lt. Dinwiddie entered the Strip en route to the Shivwits country. The two survey groups had their first face-to-face encounter at Pipe Springs on November 24, and two days later, they crossed paths again near Mount Trumbull (Gregory 1939:106; Dellenbaugh 1984:258). Although they maintained cordial relations and exchanged some information on these occasions, the overlap between the two surveys eventually resulted in considerable friction between Powell and Wheeler (Lavender 1982:131).

Powell returned to the Arizona Strip in the summer of 1873, accompanied by the painter, Thomas Moran. If Powell's original intention was to bring the scenic grandeur of Grand Canyon to the attention of the American public, he could not have chosen a better artist for the job. Moran had already received public acclaim for his painting, Grand Canyon of the Yellowstone, and his subsequent expansive portrayals of the Grand Canyon captured not only the public's imagination but, more importantly, brought the region to the attention of the U.S. Congress. A painting depicting the view from Point Sublime was purchased by the federal government in 1874 for $10,000. With Moran's glorious rendition of the Grand Canyon vista hanging in the main hall of the Capitol, future funding for Powell's topographic survey was virtually assured (Pyne 1982).

In addition to acquiring the services of Moran, Powell's survey gained additional personnel the following year in the form of two well respected geologists, Grove Karl Gilbert and Clarence Dutton. The addition of Gilbert and Dutton added a significant measure of scientific credibility to Powell's ongoing survey work north of the Grand Canyon. Gilbert, formerly a member of Lt. Wheeler's rival survey, was already familiar with the Colorado River region when he joined up with Powell's team. In 1871, he accompanied Lt. Wheeler on his upstream journey through the lower Grand Canyon to the mouth of Diamond Creek, and in 1872, he traveled with Lt. Dinwiddie's survey party south from Kanab to the North Rim and down Kanab Creek to the Colorado River (Pyne 1982:24). Gilbert had become increasingly frustrated with the regimented organization and scientifically narrow-minded approach of Wheeler's survey as compared Powell's more loosely structured operation and his genuine interest in the geology of the region. Thus, when the opportunity arose to switch alliegances, Gilbert was quick to do so.

Although Gilbert's major scientific contributions, such as his landmark studies of the Henry Mountains (1877) and Lake Bonneville (1890), dealt with subjects outside the Arizona Strip, he did make some contributions to scientific studies on the Arizona Strip (1875). For example, during his survey of the Gunnison baseline, he developed a new and more accurate method for measuring elevation above sea level, and in 1878, returned to the Arizona Strip to recalculate the elevations of Thompson's mapping stations and remeasure the position of the Kanab baseline (Gannett 1894). At this time, Gilbert erected stone monuments at either end of the baseline; the southern one, somewhat altered from its original appearance, can still be found approximately three miles south of Fredonia (Olsen 1969:268). Dendrochronological cutting dates recovered from the Brow Monument on the Kaibab National Forest suggest that during this visit, Gilbert also stabilized some of the original survey monuments erected by Thompson's crew in 1872 (Cleeland 1987a). Gilbert's revised data were subsequently incorporated into the first USGS topographic quadrangle maps of the Arizona Strip region.

Dutton, unlike Gilbert, had no prior experience on the Colorado Plateau when he joined Powell's survey in 1875. An eminent scientist of his day, Dutton was also a life-long employee of the U.S. War Department. Powell and Dutton became acquainted in Washington, D.C., and through the influence of Powell's friend and former commander, President Ulysses S. Grant, Congress passed a special act detailing Dutton to Powell's staff. Dutton retained this position for the next 15 years (Pyne 1982).

Powell, in the meantime, had became increasingly preoccupied with his studies of Native American languages and culture, and in 1879, he was put in charge of the newly created Bureau of Ethnology. When the Powell, King, Hayden, and Wheeler surveys were consolidated as the U.S. Geological Survey in 1879, Clarence King was chosen as the first director of the agency. King immediately assigned Dutton the task of completing Powell's study on the geologic history of the Grand Canyon region. Beginning in the summer of 1879 and continuing through 1881, Dutton explored the entire Arizona Strip region. A base camp was established in DeMotte Park during the summer of 1879 (Dutton 1882:135). Dutton concentrated on deciphering the geologic strata, while his assistants, Sumner H. Bodfish and J. H. Renshawe, prepared detailed topographic maps of the Kaibab Plateau. Field work during the 1880 season concentrated on the Uinkaret and Shivwits plateaus. The topographic mapping project, completed in 1880, provided base maps for the geologic atlas that accompanied Dutton's landmark 1882 publication, Tertiary History of the Grand Canyon District.

Another lesser known, but nonetheless important Powell protege who conducted scientific studies on the Arizona Strip in the early 1800s was Charles D. Walcott. Walcott first worked on the Colorado Plateau under Dutton in 1879. Two years later, at Powell's urging, he undertook his own project in the Grand Canyon. Powell, who succeeded King as head of the United States Geological Survey in 1881, accompanied Walcott to Kanab, and with the aid of several local men, he and Walcott blazed a horsetrail down an old Indian route into the Nankoweap Basin. The trail was initially developed to supply a base camp where Walcott spent the winter of 1882-1883 working out the stratigraphy of the Grand Canyon Series and Chuar Group formations in the eastern canyon (Pyne 1982:27-28). The remains of Walcott's camp, which lies within the boundaries of Grand Canyon National Park, are still visible today, while the horse path from Saddle Mountain down Nankoweap Creek continues in use as a popular hiking trail now known as the Nankoweap Trail (McKee 1948:299).

Native American Responses to Mormon Settlement

Conflicts between Mormons and Paiutes continued on a sporadic basis following the close of the so called Black Hawk War. Most of these conflicts took the form of livestock raids by Paiutes, followed by retaliatory actions from Mormons. Although local Paiutes were undoubtedly resposible for some of the depredations against the Mormon settlements (see for example, Euler 1966:91), they were sometimes wrongly accused and punished for raids committed by Navajos and San Juan Paiutes from across the river. These incidents perpetuated ambivalent attitudes between Paiutes and Mormons. This relationship is illustrated by the lifestory of Kwagunt, a late eighteenth century Kaibab Paiute who lived near the canyon that bears his name. According to Brigham Riggs, an early twentieth century rancher from Kanab, Utah, Kwagunt developed a life-long hostility towards the settlers of Kanab after his entire family was killed by Anglos who had accused them of stealing cattle that in fact had been run off by Navajos (Euler 1966:86-87).

The combined effects of disease, raiding, and the destruction of native habitat by Mormon livestock resulted in widespread starvation and a precipitous decline in the already drastically reduced Paiute population (Stoffle and Evans 1978). As noted earlier, estimates of the mid-nineteenth century Kaibab Paiute population range from a low of 500 to a high of 1,800 (Kelly 1964; Stoffle and Evans 1978). By 1873, Kaibab Paiutes numbered 207 individuals (Powell and Ingalls 1874). Based on Stoffle and Evan's lowest estimate of 1,200 Kaibab Paiutes in 1850, this represents a decline of over 80 percent in one generation. If Kelly's estimates are used, a decline of more than 50 percent is indicated. Either way, it is clear that Mormon settlement had a devastating impact on the aborginal population of the Arizona Strip.

John Wesley Powell developed a keen interest in the traditional culture and general welfare of the Southern Paiute during his tenure on the Arizona Strip. In January 1872 a growing concern over their deteriorating condition prompted Powell to send a letter to Charles F. Powell, U.S. Special Indian Agent, pleading for assistance for the "Unkars, Kanigets, Kaibabits, and Shewits" (Darrah 1951:179).

> All of these bands are in a destitute condition. . . . The Indians are begging from the Whites, who are themselves poor by reason of the grasshoppers. The Kaibabits are encamped about three miles from me and I have visited them often and I find them in a truly suffering condition. They have exchanged their ornaments and clothing for food and do not have enough. Can you do something for them? It will be an act of humanity. . . .

Powell's publicized concern for welfare of the Native American inhabitants of the Colorado Plateau and Great Basin region led to his subsequent appointment as Special Commissioner of Indian Affairs in the spring of 1873. Along with George W. Ingalls, Indian agent for Southern Nevada, Powell was charged with investigating the "conditions and want" of the Numic-speaking peoples of the Great Basin region, particularly those bands that had yet been confined to reservations. Powell and Ingalls traveled to Salt Lake City in May 1873 to meet with delegations of Utes, Gosiutes, and Shoshones before continuing on to the Arizona Strip.

The commissioners visited the various bands residing on the Arizona Strip and in the vicinity of Kanab, Utah, then returned to St. George in early September for a general meeting with Paiute delegations from the surrounding region (Fowler and Fowler 1971a:11). A report on the commissioners' findings, including a census of the various bands, was submitted to Congress the following year (Powell and Ingalls 1874). The commissioners' census of the Southern Paiute, not including the Chemehuevi, found 2,027 individuals distributed among 31 bands. Only two bands, the Shivwits (182 members) and the Uinkarets (40 members) were identified as living exclusively on the Arizona Strip. The Kaibabvits, whose traditional ranged centered around Kanab, Utah, but included most of the Strip country east of Kanab Creek, numbered 131 individuals. Other bands whose traditional territory bordered on or overlapped slightly with the Arizona Strip included the Un-ka-ka'-ni-guts, Pa-spi'-kai-vits and the U'-ai-Nu-ints. The first two of these "bands," which later ethnographers considered to be subunits of the Kaibab Paiute (Kelly and Fowler 1986:395), numbered 36 and 40 individuals respectively. The third band, with a population of 80, resided near St. George.

In keeping with the prevalent attitudes of the times, the report recommended that all the Southern Paiute bands be gathered together on the Moapa Reservation in southeastern Nevada where they could be taught to be self-sufficient farmers. Specifically, it recommended that the Indians not be given any more annuities unless they showed a willingness to become farmers, in which case the annuities could serve as compensation for their labor. Powell and Ingalls suggested that houses be constructed on the reservation as soon as possible to discourage the Paiutes from pursuing their nomadic lifestyle and that professional farmers, blacksmiths, carpenters, and other skilled craftsmen be assigned to teach the Indians the necessary skills for sustaining themselves as sedentary agriculturalists. They noted that the Moapa Reservation was well suited for agricultural subsistence, having been successfully farmed with irrigation by previous Mormon residents of the valley. Nevertheless, it was clear that the existing reservation would have to be expanded to include additional farm and timber lands and that white settlers remaining within the boundaries of the reservation would have to be removed in order for the resettlement program to be successful.

The Moapa Reservation had been created by executive order in 1873 "for the use the Indians of that locality" (Kappler 1904:866). Acting promptly on the commissioners' recommendations, President Grant issued another executive order on February 12, 1874, expanding the Moapa Reservation to include additional irrigable land and timber. This expanded reservation included approximately 2,000,000 acres (Rambeau and Holmes 1976:96). Barely a year later, however, agitation from white settlers in the region resulted in the reservation being reduced to 1,000 acres (Kappler 1904:157; Rambeau and Holmes 1976:95). This factor, plus a lack of forthcoming appropriations, discouraged the Paiutes from moving to the Muddy Valley (Kelly and Fowler 1986:388).

The Paiute's refusal to leave their traditional territory may have been motivated by more than a simple attachment to the land. According to Stoffle and Dobyns (1983:43), the Paiutes believed (and continue to believe) that they were created in this area and that the supernatural forces responsible for their creation also resided in the area. These spiritual beings had a protective influence over the health and general welfare of succeeding generations, and they were specifically helpful in warding off sickness and other malevolent forces generated by sorcery. The Paiutes feared that they would loose this protection if they moved away from the area (Stoffle and Dobyns 1983:43).

The federal government did not pursue efforts to force the Paiutes' removal. During the 1870s and into the 1880s, the Indians continued to eak out a precarious existence within their traditional range, but with ever-dwindling success. In November, 1880, Jacob Hamblin sent a letter to Major Powell describing the desperate circumstances of the Indians living near Kanab (Fowler and Fowler 1971a:22).

> The Kanab or Kaibab Indians are in very destitute circumstances; fertile places are now being occupied by the white population, thus cutting off all their means of subsistence except game, which you are aware is quite limited. . . . The foothills that yielded hundreds of acres of sunflowers which produced quantities of rich seed, the grass also that grew so luxuriantly when you were here, the seed of which was gathered with little labor, and many other plants that produced food for the natives is all eat out [sic] by stock.

Hamblin reminded Powell that he had offered to assist the Paiutes in the past and begged him to "secure some surplus merchandise for the immediate relief of their utter destitution." Powell's reply to Hamblin was far from encouraging. In a letter dated February 18, 1888, Powell claimed that it would be impossible for him assist the Indians unless they went to the agency at Uintah or Moapa, noting that it was Administration policy not to assist those Indians who did not report at agencies "the object being to get them together at such places in order that they may be taught carefully, and given homes in severalty as soon as they are competent to take care of themselves (Fowler and Fowler 1971a:22)."

The depletion of their traditional food sources forced the Paiutes to pursue alternative adaptive strategies (Stoffle and Evans 1978:17). One strategy was to accept conversion to the LDS faith, thereby forcing the Mormons to deal with them on a more equitable basis and share their products more freely (Stoffle and Evans 1978:17). Historical accounts suggest that the mass baptism of the Shivwits band at St. Geroge in 1862 was motivated by the desire to obtain clothing and other material goods (McClintock 1985:67). Another strategy involved readjustment of the tradional sociopolitical system. There is little evidence to suggest that the Paiutes ever functioned as a tribe under the leadership of a single individual prior to the 1870s (cf. Stoffle and Dobyns 1983:47). The best available ethnographic evidence indicates that the traditional leadership positions, such as rabbit hunt "chief," were task specific (Kelly 1964; Euler 1966; Kelly and Fowler 1986). The lack of a clearly defined chief made it difficult for Mormons or government officials to deal with the Paiutes, since the opinion of one individual was not considered binding on other members of the band. During the 1870s, however, the Paiutes began to accept the notion of a "chief." Stoffle and Evans (1978:18) suggest that the Paiutes may have made this adjustment in order to enhance their negotiating powers and thereby extract more resources from the dominant society.

Their traditional material culture underwent considerable change during the 1870s and 1880s. Initially, projectile points made of iron and glass and steel knives replaced the traditional stone implements (Euler 1966:115); after the mid-1870s, when the Paiutes no longer posed a significant threat to the Mormons, possession of firearms became increasingly common, although steel-tipped arrows continued in use past the turn of the century (Belknap 1941). Iron and brass containers were substituted for pottery, and the traditional men's breechclout and women's apron skirts were replaced by cast-off clothing from the Mormons. Basketry technology persisted, however, perhaps because the gathering of wild plant foods continued to be an important subsistence activity (Stoffle and Evans 1978).

The Mormons were well aware of their role in reducing the Paiutes' traditional subsistence base, and made a conscious effort to ameliorate the consequences by supplying seeds and tools and encouraging the Paiutes to copy their agrarian lifestyle (Larson 1961:539-542). These efforts generally fell far short of their intended goals and left the Mormons increasingly frustrated by what they perceived as the Paiute's inherent disdain for hard work (Larson 1961:540). The Paiutes, in turn, resented the Mormons for usurping the most productive portions of their former range, particularly the lands around the springs, and then expecting them to work twice as hard for what was rightfully theirs. This situation continued with little obvious improvement through the 1880s.

As new settlers and non-Mormon sheepherders began entering the Strip in increasing numbers during the 1880s, the situation reached crisis proportions. The newcomers were far less tolerant of the Paiutes and were less inclined to overlook the occasional disappearance of a steer or sheep. They did not recognize the Paiute's rights to live around the springs and the resulting disputes sometimes led to bloodshed. Sometime during the late 1880s, Church leaders acknowledged the need for a permanent solution to "the Indian Problem." In 1891, local rancher and church leader, Anthony Ivins, obtained an appropriation from the federal government to purchase farmland along the Santa Clara River for a Shivwits Reservation (Larson 1961:543). Although some accounts suggest that the Shivwits moved eagerly to their new reservation (e.g., Cox and Russell 1973:10), other accounts indicate that the Indians were moved by force (Rambeau and Holmes 1976). Members of the Gunlock, St. George, and Uinkaret bands also moved to the Shivwits Reservation about this time (Kelly and Fowler 1986:389). Ivins, who served as Indian agent for the Shivwits during 1891-1893, established a school there in the mid- 1890s. The reservation did not become official property of the federal government until 1903. The boundaries were subsequently expanded in 1919 and 1937 to include a total of 28,160 acres (Rambeau and Holmes 1976:117).

The manner in which the Kaibab Paiutes obtained rights to one-third of the water from Moccasin (Sand) Springs remains obscure. Some accounts indicate that they acquired the water rights in the late 1870s, either from the Canaan Cattle Company or from the Orderville United Order (OUO), who bought the claim from the Canaan Cattle Company (Robinson 1970:481-482; Malach 1979:9). These statements are probably in error. A more plausible account is provided by Lavender (1984:42) who states that the water was donated by the Heaton family at the request of the LDS Church; the Heaton family had acquired a two-thirds claim to the spring when the property of the OUO was divided among its members in the mid-1880s. When James Brown, a special agent to the Kaibab Indians, visited the settlement at Moccasin in 1904, he found seven irrigated acres under cultivation. These crops sustained the band through the harvest season; during the remainder of the year, they earned wages by doing menial labor for the neighboring Mormons, principally fieldwork by the men and washing by the women (Brown 1904:329).

In 1907, the federal government set aside a 12 by 18 mile area surrounding the privately owned ranches at Moccasin and Pipe Springs. The boundaries were adjusted in 1913 and again in 1917 to ultimately include a total of 120,413 acres (Euler 1972:82; Farrow 1930:58). Today, the Kaibab Reservation is home to approximately 100 members of the 200 member band. Approximately 400 acres of land are under cultivation and there are plans to develop additional water sources in order to expand the cultivated fields (Brunson and Coats 1980). Grazing by Mormon- owned cattle under a lease agreement with the tribe provide one of the few sources of reliable revenue for the Kaibab Paiutes. Although housing and other necessities are provided through government assistance programs, the band remains poverty stricken. This situation is directly traceable to several factors: a lack of essential resources, a lack of marketable skills, and a scarcity of employment opportunities in the nearby community. As demonstrated by the foregoing discussion, each of these problems originated with and can be traced back to the inception of Anglo-Paiute interactions on the Arizona Strip.

HISTORY OF ECONOMIC DEVELOPMENTS ON THE ARIZONA STRIP; 1870-1950

Ranching

In the spring of 1870, as Indian hostilities died down and settlers began drifting back to their abandoned settlements on upper Kanab Creek and the Paria River, Brigham Young took a tour of the country south of the Virgin River. Stopping at Pipe Springs while en route to Kanab, the church leader was quick to recognize the potential of that region as a base of operations for a church-owned cattle ranch. Since very little currency was circulating in the southern colonies at that time, tithings to the LDS Church consisted largely of livestock and farm produce, and as a consequence, the Church had acquired a considerable herd of cattle. The ranges in the vicinity of St. George were already stocked to capacity, and the Church needed an alternative area for its rapidly growing herds (Lavender 1984:22). With its ample water supply and its location on the edge of a vast grassland adjacent to an established wagon road, Pipe Springs was ideally suited for a large scale ranching enterprise.

Upon his return to St. George, Young took immediate steps to turn his vision into a reality. On April 9, 1870, he and several other community leaders from the St. George area formed the Canaan Cooperative Stock Company, the assets of which were to be owned jointly by the Church and other individuals who chose to participate (Larson 1961:237). Shortly thereafter, Young purchased the Whitmore estate in the name of the Church, and sent Asnon P. Winsor to Pipe Springs to improve the spring and take charge of the livestock. In September 1870, Young returned to Pipe Springs and demarcated the outline for the proposed ranch headquarters, which could double as a fort if circumstances demanded it. The massive stone building, which was finished in 1872, soon became known as Winsor's Castle (Lavender 1984). By that time, the Pipe Springs herds included approximately 500 cattle and a number of horses (Olsen 1969:19; Kelly 1948-1949:403).

In developing the ranch at Pipe Springs, Young may have been anticipating the need for a church-controlled dairy farm to help supply food for the large labor force that would soon be involved in building the temple in St. George. In 1871, the Canaan Cooperative Stock Company was dissolved and a new and expanded version called the New Canaan Stock Company was incorporated. James Andrus, a former captain in the southern Utah militia and a key figure in the recently completed military campaigns against the Navajo, was appointed superintendent of the company. A new ranch headquarters was established at Canaan Spring, approximately twenty miles northwest of Short Creek.

Pipe Springs continued to serve as an auxillary ranch and dairy farm. This reorganization coincided with the commencement of the ambitious temple construction project at St. George. For the next six years, the New Canaan Stock Company subsidized the temple work by contributing beef and dairy products to sustain the massive labor force.

In 1873, the Winsor Castle Stock Growing Company was organized as an off-shoot of the Canaan Cooperative, with Pipe Springs as its headquarters (Crampton 1965:158). Like those of its parent company, shares in the Winsor company were owned by the Church and several individuals, including Anson Winsor and Brigham Young. The beef and dairy products produced at the ranch continued to be transported to St. George on a regular basis to feed the temple laborers (Lavender 1984:31). In January, 1879, the Winsor Castle ranch was reconsolidated with the Canaan company (Larson 1961:242).

Meanwhile, a number of small-scale ranching operations were established in other corners of the Strip. In December 1871 John D. Lee started work on the ranch at Lonely Dell. A few months later, at the behest of Jacob Hamblin, Lee established claims at House Rock Springs and Jacob's Pools (Figure 46). On April 5, 1871, Lee started construction on a rock-walled structure near House Rock Springs, and two days later, he began work on another structure at Jacob's Pools (Cleland and Brooks 1983:186). The work was started none too soon, for prospectors were swarming into the area at this time; one of them had pulled up Lee's stakes at Jacob's Pools a few days previously, apparently intending to claim the pools for himself. It is not clear if the structure at House Rock was actually completed by Lee, but when Walter C. Powell came through area in July, he mentioned that there was an unoccupied rock cabin at that location (Kelly 1948-1949). The structure at Jacob's Pools, consisting of a one room, willow walled shanty lined with Navajo blankets, was finished in late May. By that time, Lee's wife Rachel, had arrived at the Pools with a herd of 40 cows. Later that year, Lee built a substantial stone house about a half mile from the Pools (Crampton 1965). Lee subsequently referred to this ranch by a number of names: Lee's ranch, Lee's (or Doyle's) retreat, or Rachel's Pools. The ranch at the mouth of the Paria was simply called Lonely Dell.

Early in 1871, Levi Stewart, the newly ordained bishop of Kanab, and his son John, established claim to the water at Big Springs on the west flank of the Kaibab Plateau. The Stewarts kept cattle and horses in the area, and built a couple of cabins and corrals with lumber from the Skutumpah sawmill, which had been transferred to Big Springs after John D. Lee disassociated himself from the lumber business. Powell's surveyors camped at the Stewart ranch in February 1872 and on number of occasions thereafter. On their first visit to the ranch, some of the Powell party took shelter in a half-finished cabin, and Dellenbaugh (1984:181) commented that work on the sawmill "had not gone very far." Walter C. Powell's diary entry of February 23, 1872, provides supplementary information about the facilities and functions of the Stewart Ranch. "Steward's [sic] Ranch consists of two deserted cabins and a corral. In front of the huts, a large spring falls from the cliff over a talus of limestone, 200 feet in height . . . Soon after our arival, young Steward drove up a band of horses" (Kelly 1948-1949:398).

Farther to the west, another ranching outpost was established below the flanks of Mount Logan by members of the Whitmore family from St. George (Dellenbaugh 1962:187-188). Almon Thompson and Dellenbaugh visited Whitmore's place while they were working in the area in March, 1872, but their diaries provide little information about the ranch facilities. Apparently, this ranch was located at Oak Spring, on the southeast side of Mount Logan (Woodbury 1944:190). Whitmore Springs, below the southern flanks of Mount Logan (also known as Big Spring) provided another water source for the ranch.

In the autumn of 1872, while serving as a guide to members of the Powell expedition, John D. Lee learned of the grazing potentials on the Kaibab Plateau, in the area now known as DeMotte Park.

I learned through our Indian guide a splendid ranch could be made on the Buckskin or Kaibab Mountain in a valley 15 ms long and 3/4 wide with 3 springs eaqueally [sic] divided. 2 of the springs forms [sic] quite [sic] lakes with heavy meadow land, surrounded by heavy pinereys, fur [sic] 7 quakin asp [sic] groves [Cleland and Brooks 1983:215].

Lee apparently never had time to develop this area for his own use. His ranches at Lonely Dell and Jacob's Pools, along with his intermittent ferry responsibilites, preoccupied most of his time. Eventually, Levi Stewart and his sons expanded their ranching operations on to the plateau and into the DeMotte Park area (Nelson 1959:64).

In 1878, David King Udall, the son-in-law of Levi Stewart, and his two brother-in-law, Lawrence C. Mariger and William T. Stewart, formed a private commercial partnership and acquired water rights in DeMotte Park from the Stewart estate (Nelson 1959:64). Udall planted trees in DeMotte Park in 1878 and 1879, and started a ranch there in the autumn of 1879. Fifty to 75 acres were plowed at this ranch, and one good crop of wheat was harvested from these fields (Nelson 1959:64-65, 239). Udall later congratulated himself and his partners on the success of the operation, saying, "we made no mistake in securing a ranch in DeMotte Park in the Kaibab forest on the north rim of Buckskin Mountains and the mercantile business [located in Kanab] later proved successful" (Nelson 1959:67).

The ranching enterprise in DeMotte Park came to an end for the Udall group in 1880 when the three partners were assigned to missions in other areas. Udall moved to the upper Little Colorado River area, where he played a pivotal role in establishing the community of St. Johns. In the settlement of the partnership, Udall received "two new wagons, two pair of horses, a saddle pony or two, and a bunch of cattle--about 40 head" (Nelson 1959:64). From these figures, it would appear that the partnership had at least 100 cattle on the DeMotte Valley ranch at the time of its dissolution. Following the departure of Udall and his partners, the water rights in DeMotte Park apparently passed to the United Order of Orderville.

The OUO was an outgrowth an LDS Church- sponsored cooperative movement initiated in 1874. Proclaimed by Orson Pratt and other church leaders in an attempt to overcome the effects of the economic Panic of 1873, the United Order was a supra-community commercial venture conceived within the context of the Mormon Church (Arrington 1954; Pendleton 1939a). The cooperative at Orderville, Utah, was unquestionably the longest lived and most successful of these experiments in communalism. As the name implies, the town of Orderville was initially founded as a result of the movement. Unlike most United Order communities, which typically reverted back to private enterprise after two or three years of communal experimentation, the OUO thrived for nearly a decade, and was not formally disbanded until 1900 (Woodbury 1944:184). Participating members held all possessions in common except for houses and house lots. Their labor was organized for the good of the entire community, and the products of the various community operated enterprises were shared equally by its members. A major reason for its commercial success can be traced directly to the OUO's early involvement in ranching on the Arizona Strip.

They early recognized the country afforded for stock and sheep raising, and lost no time in controlling the range by acquiring possession of watering places in southern Utah and northern Arizona. These ranches included House Rock, Jacobs Pools, Cane Springs, Castle, Elk, and one hundred and fifty acres on the Pahreah [sic] River. Many watering places were also controlled on the Kaibab Mountain. (Pendleton 1939a:149).

These water sources were not all acquired simultaneously. As the OUO flourished under the careful management of its membership, a number of individuals from surrounding communities were inspired to join and contribute their personal holdings, including privately owned water rights, to the Orderville cause. In this manner, the OUO acquired the Lewis Allen ranch at Moccasin (Larson

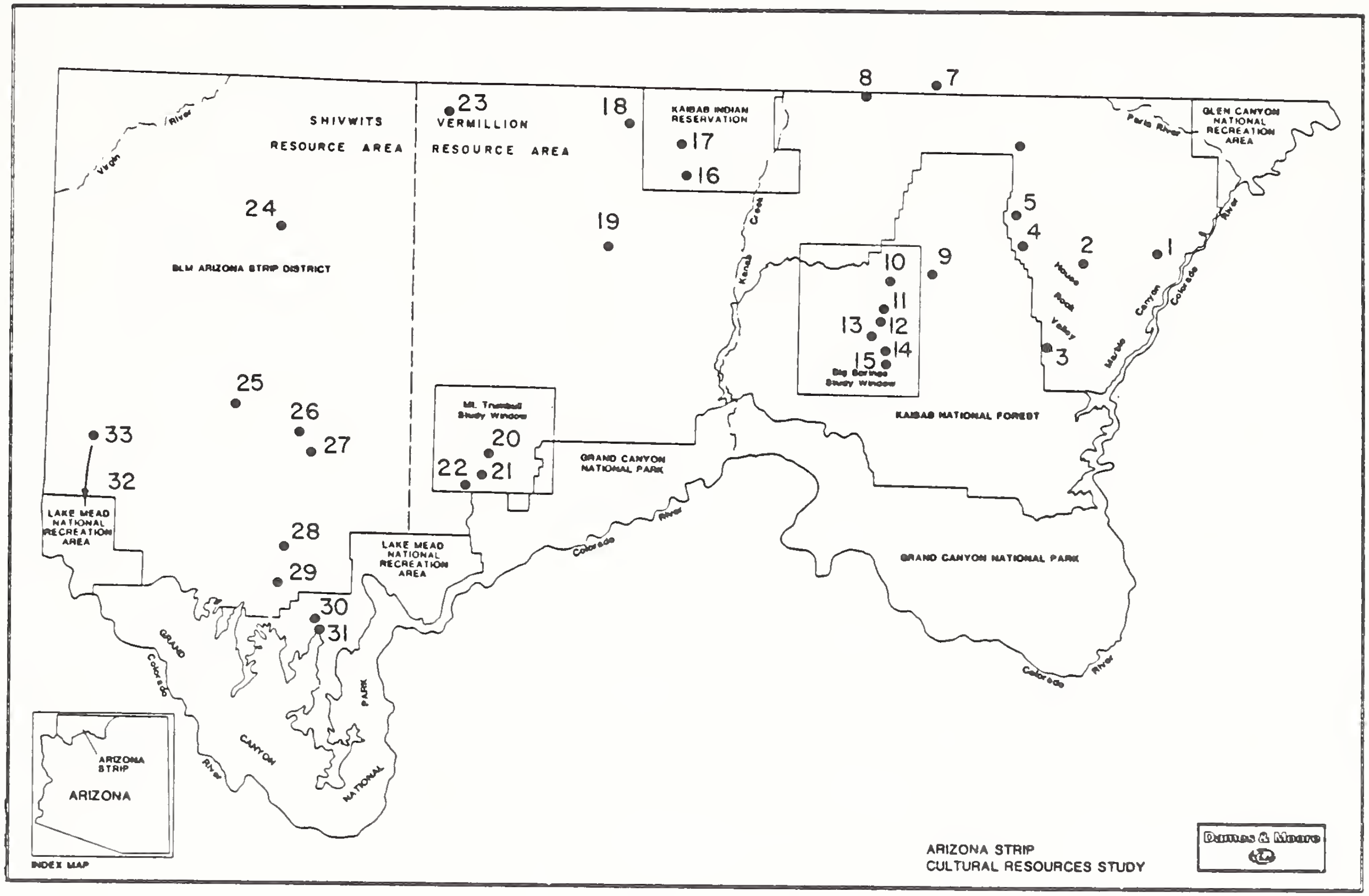


Figure 46. Important Water Sources on the Arizona Strip

Key for Figure 46

1	Soap Creek
2	Jacobs Pool
3	Kane Springs
4	Houserock Spring
5	Two-mile Spring
6	Coyote Spring
7	Navajo Wells
8	Eight-mile Spring
9	Jacob Lake
10	Warm Springs
11	Moquitch Spring
12	Mangum Spring
13	Big Springs
14	Castle Spring
15	Riggs Spring
16	Pipe Spring
17	Mocassin Springs
18	Cavebeds
19	Yellowstone Springs
20	Nixon Spring
21	Oak (Little) Spring
22	Whitmore (Big) Spring
23	Antelope Spring
24	Wolfhole Lake
25	Hidden Srings
26	Oak (New) Spring
27	Ivanpatch
28	Oak Grove
29	Log Spring
30	Green Spring
31	Penns Pocket
32	Tsasi Spring
33	Pakoon Spring

1961:305). Other water holes were acquired through direct purchase. The rapid expansion of the OUO in the late 1870s led to a growing unease among neighboring communities that the OUO might eventually absorb the whole region, since it alone had the financial resources at its disposal for purchasing property and water claims (Larson 1961:306).

In 1875, the Order owned a small band of sheep and 50 cows. The Order promised investors that the herd would double within four years. In 1881, during the heydey of its operation, the Order paid taxes on 5,000 sheep; cattle had increased ten-fold by this time (Pendleton 1939b). Sometime during this same period, the OUO established a dairy ranch in Orderville Canyon, on the Kaibab Plateau north of Jacob Lake (Coker 1978:23). Summer grazing was on the Kaibab Plateau, including DeMotte Park, and winter range was in House Rock Valley (Pendleton 1939b).

The course of events leading up to the United Order's control of most of the grazing resources on the Kaibab Plateau remains a matter of some dispute, as does the origin of the VT brand and the source of DeMotte Park's alternative name, VT Park (Coker 1978:21-22). Crampton (1965) suggests that the OUO initially acquired cattle in the mid-1870s from some non-Mormons who used the House Rock range and branded their cattle with the VT brand. Alternatively, F.M. Hodgin (1962:2) suggested that two men named Thompson and Van Sleck purchased cattle from the United Order and branded them with the VT brand. Udall says nothing about the brand he and his partners used. Cleland and Brooks (1983:94ff) quote Walter Hamblin who suggested that the VT signified "Valley Tan," a term that apparently referred to the tannery operated by the OUO in Long Valley; according to Hamblin, the VT brand distinguished church-owned tanned hides from imported hides. Gery and Smith (1915:5) imply that the VT brand was used by a group of ranchers who operated in the area concurrently with the OUO. To confuse the issue even further, Granger (1983:80) claims that the OUO herds were managed by Van Slack and Thompson, both of whom were members of the Orderville community, but that the VT name referred to a brand signifying "Valley Tan"!

It is doubtful whether this issue will ever be satisfactorily resolved. Few brands of this period were officially registered in county or state records, and brand ownerships changed hands or were modified quite frequently, making it difficult to establish the priority of ownership for any given brand. As best as can be determined at the present time, the VT brand came into existence sometime during the mid-1870s or early 1880s (Crampton 1965). For a time, the VT outfit ran cattle on the eastern Strip concurrently with the OUO (Gery and Smith 1915:5). The VT outfit apparently concentrated their winter operations in the lower portion of House Rock Valley, south of Kane Springs, and used the southern portion of the Kaibab Plateau during the summer, while the OUO dominated the northern areas (Woodbury 1944:190).

In the mid-1880s, threatened by the passage of the 1887 Edmunds-Tucker Act, the OUO began divesting itself of its ranches and other commercial enterprises. Two years previously, the Supreme Court had upheld the constitutionality of the 1882 Edmunds Act, which sought to abolish, once and for, the Mormon practice of plural marriage; one of its main provisions allowed the U.S. government to confiscate property belonging to practicing polygamists. The Edmunds-Tucker Act strengthened and extended the provisions of the 1882 bill and included several new provisions designed to reduce the temporal powers of the LDS Church. In particular, it gave the federal government the right to auction off any holdings of the LDS Church that were not specifically linked to religious functions. In order to retain a measure of control over its commercial holdings, the Church transferred its property to private hands. In most cases, Church leaders acquired the property, serving as defacto trustees for the Church's interests (Arrington 1954).

Due to internal dissension within the OUO, some aspects of the cooperative had already been relinquished to private management by the time the Edmunds-Tucker Act took effect. Farmers and ranchers were permitted to retain a share of the produce and livestock, while sawmills and freighting operated on a contract basis. Thus, passage of the Edmunds Tucker Act only hastened a trend that was already in progress (Pendleton 1939b). Ownership of the OUO livestock and ranching facilities was transferred to members of the Order, some of whom in turn sold their shares to outside private concerns.

John W. Young, the son of Brigham and an elder in the LDS Church, apparently acquired control of OUO holdings on the Kaibab at this time. It was during this same period, according to Gery and Smith (1915:5), that the VT and OUO ranches were combined to form the Kaibab Cattle Company. During the late 1880s, while serving as a missionary in England, Young developed a grandiose plan for turning his ranch and the surrounding area into a sporting playground for wealthy English aristocrats (Woodbury 1944:190; see also discussion on recreation below). According to Woodbury (1944:190), after the plan fell through, Young sought to recoup his losses by reorganizing the ranching operation as the Kaibab Land and Cattle Company, using money borrowed from New York bankers. Another account (Mann 1941:8) claimed that the Kaibab Cattle Company was bought out at this time by Cannon and Grant of Salt Lake City through the redemption of bonds; these men then hired Anthony W. Ivins to manage the ranch for them (cf. Woodbury 1944:190). In 1896, the ranch was sold to investors from Beaver, Utah, who promptedly sold it to B.F. Saunders (Gery and Smith 1915).

The Edmunds Tucker Act of 1887 also fostered the dissolution of the Church-controlled Canaan Stock Company, although depletion of the range was another significant factor contributing to its demise. Over the years, the Canaan Company, had acquired rights to many important water sources on the western part of the Strip, including Antelope Springs near the Canaan Ranch headquaters and Oak Grove Spring, about four miles northwest of Mount Dellenbaugh at the head of Parashont Wash, a major tributary of Andrus Canyon (Belshaw and Peplow 1978:II-27). (The latter drainage was presumably named after the company's superintendent, James Andrus [Crampton 1965:157]).

In 1879, the Canaan Company established a dairy ranch at Oak Grove. The company hired a St. George resident, Albert Foremaster, to take charge of the dairy operation. Albert's daughter, Florence Foremaster, provided a brief account of this early ranching operation (1977:5). "When Albert became foreman of the Canaan herd at Parashaunt in the Spring of 1880, he hired his brother Eph to help him. They milked 25 head of cows and made butter and cheese which they sold in St. George. They also had pigs which they turned loose to fatten on acorns." The Grand Gulch copper mine provided another major outlet for the dairy's products, as did the sawmill at Twin Springs Canyon, which produced timbers for the Grand Gulch mine (Larson 1961:243; Belshaw and Peplow 1978:II-27).

Florence Foremaster's reminiscences about her father's life also contain a poignant comment on the damage caused by livestock to the grasslands surrounding Parashont: "Daddy said that when they first moved to Parashaunt it was like a meadow everywhere, but over-grazing has changed all that" (Foremaster 1977:5). One might be tempted to discount this statement as just another example of the "Lost Eden Syndrome," if it were not for the fact that the theme reoccurs again and again in the historical literature of the Arizona Strip. As early as the late 1870s, livestock damage to the fragile desert grasslands was apparent to visitors and ranchers alike. Clarence Dutton, a witness to the demise of the range in the late 1870s, painted with his inimitable prose a vivid picture of the rangelands south of Pipe Springs around 1880.

> Ten years ago, the desert spaces outspreading to the southward were covered with abundant grasses, affording rich pasturage to horses and cattle. To day hardly a blade of grass is to be found within ten miles of the spring, unless upon the crags and mesas of the Vermilion Cliffs behind it. The horses and cattle have disappeared, and the bones of many of the latter are bleached upon the plains in front of it (Dutton 1882).

Dutton attributed the denudation of the grasslands two factors: overgrazing and recent drought. He noted that the native grasses of the Arizona Strip were predominantly of the bunch variety and reproduced from seeds, rather from than perennial root systems. Overgrazing, in conjunction with a dry spell during the mid- to late 1870s, had reduced the seed- producing stock below the level required to sustain itself.

The fact that the Arizona Strip was heavily overgrazed during the 1870s cannot be disputed. The devastation was in part a consequence of expanding herds of feral horses and cattle, and partly a consequence of the Mormon philosophy, which encouraged settlers to expand their claims throughout the area and work industriously to better themselves and make their communities and Church self-supporting. Throughout this period, the range was considered open to all who could make use of it. Use of the range, however, required access to that one very limited and precious commodity: water. In keeping with their traditional cooperative outlook, Mormon ranchers maintained an open policy towards the use of stock watering lcoations. individual ranchers who assumed responsibility for the upkeep of improvements at specific springs and watering holes were considered to be the rightful "owners" of these sources and were accorded priority use rights, but other stockmen were not restricted from availing themselves of these sources if the supply was sufficient to support additional use. As noted by Gery and Smith (1915:5), "individual possessory claims were acknowledged and respected by stockmen grazing cattle in that particular section of the country, but such acknowledgement did not go to the extent of admitting exclusive right". This informal and open policy not only encouraged over-use of the range, but it also left the water sources and the surrounding range, open to use by stockmen from outside the area, some of whom did not share the local ranchers' time honored approach towards range and water use rights.

To a certain extent, however, the overstocking of the ranges during the 1870s was due to circumstances beyond local ranchers' control. In 1870 and 1871, and again in 1876 and 1877, California suffered from a succession of severe doughts, and as result, large numbers of sheep were driven eastward across the Colorado River into Arizona. It was during this period that sheepherders first began grazing their flocks on Arizona Strip (Haskett 1936:21-22). This initial use, although transient, involved substantial herds. For example, in an April 1872 diary entry, Walter Clement Powell casually mentioned that 11,000 sheep were grazing in the vicinity of Pipe Springs (Kelly 1948-1949:403). After the first wave of sheepmen passed through the area, others soon followed in their footsteps. Some California and Nevada sheepmen began using the Arizona Strip for winter range on a regular basis, and a number of men from St. George and Kanab took up sheep herding for the first time. Sheep were an attractive investment for aspiring ranchers of little means, because they did not require large capital outlays or control of an abundant water supply to get started in the business.

In 1883, prompted by declining profits, which resulted in part from the declining quality of the range, the Canaan Company sold the Oak Grove ranch to Benjamin F. Saunders, a wealthy non-Mormon cattleman from Salt Lake City (Larson 1961:245-246). Saunders' entry on the Arizona Strip marked the beginning of a new chapter in the ranching history of the Arizona Strip. From this time forward, the range and water became increasingly concentrated in the hands of non-Mormon cattle barons. The days of exclusive Mormon control of the Arizona Strip were rapidly drawing to a close.

In 1884, management of the floundering Canaan Company was transferred to the OUO, in hopes that the Order might restore the company to profitability (Arrington 1954). When passage of the Edmunds-Tucker Act in 1887 forced the OUO out of the cattle business, the Canaan Company underwent another reorganization. Some properties of the Canaan outfit were passed on to individual share holders in the company, including Anthony Ivins and John W. Young. Ivins' acquired 600 head of cattle, which formed the seed stock for the Mohave Land and Cattle Company based at Oak Grove, while Young acquired a similar size herd, which he promptly moved to his new ranch in the House Rock Valley-Kaibab Plateau region (Belshaw and Peplow 1978:II 30; Lavender 1984:38). The Canaan ranch headquarters and brand were retained, but the company was reorganized as a quasi-private enterprise. It continued to operate on this limited basis until 1895 (Larson 1961:247).

Under pressure from federal marshals, the Pipe Springs ranch was put up for auction at this time. It was quickly bought by Saunders, who had sold the Oak Grove Ranch to Anthony Ivins, his former field manager (and a leading Canaan Company stockholder) during the previous year (Belshaw and Peplow 1978:II-30). Some accounts suggest that Saunders initially served as a "front" for the LDS Church, buying up the principal water rights and ranches of the OUO and Canaan company as they came up for auction, with the intention of selling them back to company shareholders at a later date (Lavender 1984:38). Saunders, although not a Mormon, was apparently sympathetic to the Church's plight during this difficult period, and may indeed have played this role at the outset of his involvement on the Arizona Strip. Certainly the intricate wheeling and dealing that accompanied the transfer of Oak Grove and Pipe Springs are suggestive of some collusion between Saunders and members of the LDS hierarchy. It is also certain, however, that Saunders was first and foremost a businessman who recognized a good investment opportunity when he saw one. This is clearly demonstrated by the sequence of events that followed his initial purchases.

Saunders readily perceived the possibility of controlling the valuable Strip rangelands by establishing exclusive claims on its limited water resources. That his ultimate goal was to control the range for his personal use is demonstrated by the approach he used in attempting to secure exclusive rights to prominent watering places across the Strip. Unlike Preston Nutter, another wealthy Utah cattleman who also aspired to this goal and subsequently played a pivotal role on the Strip, Saunders acquired water rights from local stockmen in the traditional manner through direct purchase. None of these rights were exclusionary, however, so Saunders proceeded to file bogus mineral claims on tracts of land surrounding these sources. In the western Strip, Saunders filed placer claims on a dozen different locations, including Oak Grove, Mokiac, and Penn's Pocket (Gery and Smith 1915:39). On the eastern Strip, mining claims and millsites were filed on Jacob's Pools, Emmett Spring, House Rock Spring, One mile Spring, Two Mile Spring, Kane Spring, Jacob Lake, Mile and a Half Lake, Crane Lake, and a half dozen or so other watering locations on the Kaibab Plateau (Gery and Smith 1915:8-12).

Saunders never controlled all of these water sources at one time, but he did control large numbers of them simultaneously. Initially Saunders concentrated his investments in the Shivwits region. In addition to the Parashaunt Ranch, he acquired interests in several springs in Hidden Canyon; he also purchased one half interest in the Hidden Springs ranch and one third interest in the Wild Cat Ranch (Gery and Smith 1915: Appendix, 6). When the Canaan Company liquidated its holdings in 1895, Saunders saw an ideal opportunity to expand his empire eastward. He quickly divested himself of his claims in the western Strip and the ranch at Pipe Springs, and used the proceeds to acquire the old Canaan Company ranch headquarters (Belshaw and Peplow 1978:II-30). Three years later, in 1899, Saunders purchased the Kaibab (VT) ranch, which included virtually all of the major water sources on the east flank of the Kaibab Plateau and in House Rock Valley, and the following year, he bought the Canebeds Ranch (Gery and Smith 1915:Appendix, 24-26, 51-55).

Saunders found a ready buyer for his Parashaunt claims in Preston Nutter, a wealthy Utah cattleman who had recently developed an interest in the grazing possibilites on the western Strip. In the autumn of 1893, Nutter had purchased 4,650 head of cattle from ranchers in central Arizona, intending to place them on his newly acquired grazing leases near Strawberry, Utah. His cowboys swam the entire herd across the Colorado River at Scalon's Ferry. By the time the cattle had been counted and branded and the drive northward got underway, winter weather was approaching. Not wishing to risk a late season drive across Utah's high country, Nutter decided to winter the herd on the Arizona Strip. Thus, began Nutter's extended tenure in the country west of the Hurricane Cliffs (Price and Darby 1964:242- 243).

Nutter, like Saunders, recognized the value of the Strip as a winter spring breeding grounds and saw the possibilities of controlling this area through its water sources. Since few of the local Mormon ranchers had established legal claims to their watering places, Nutter was quick to exploit this situation to his advantage. Nutter's daughter, Virginia Price, states that Nutter "took necessary steps to acquire legal titles on some of the land and springs, using preferred Indian scrip that he bought in Washington, DC, at a premium price" (Price and Darby 1964:244). Nutter may have claimed to have acquired titles in this manner in order to force his competitors into admitting defeat and relinquishing their claims, but there is no evidence that he actually purchased these scrips (Belshaw and Peplow 1978:A-16). Instead, it appears that Nutter exploited the provisions of an 1897 land exchange act to achieve the same ends (Gery and Smith 1915:39). This act allowed owners of private land situated within the boundaries of U.S. Forest Reserves to select other parcels from the public domain in lieu of their forest holdings. Nutter acquired a section of forest land in California and then proceeded to file a series of lieu selections on 40 acre tracts surrounding 32 different springs and pockets, amounting to virtually every usable water source west of the Hurricane Cliffs (Gery and Smith 1915:39).

Although Nutter's approach was a clear abuse of the 1897 act, it produced the desired effect. In addition to buying out Saunders interests, Nutter acquired Wolf Hole from M.W. Andrus for $300, and in 1898 he acquired "Mr. Foster's range rights, 1/2 of Big Spring, and 2000 cattle" as well as Andrew Sorenson's 500 cattle and all his claims and rights (Price and Darby 1964:244). By 1900 Preston Nutter had acquired control of almost all of the Arizona Strip and by 1901 had an estimated 25,000 cattle on it. Despite constant challenges from local ranchers, which culminated in an investigation by the General Land Office in 1915 (Gery and Smith 1915), Nutter maintained his dominance over the Strip's western range until his death in 1936.

Meanwhile, on the eastern side of the Strip, B.F. Saunders continued to oversee his interests at the Canebeds Ranch and in the House Rock Valley Kaibab-Plateau region. Around 1905, Saunders became indirectly involved in an unusual cattle breeding experiment. In the summer of that year, the former buffalo hunter turned conservationist, C.F. "Buffalo" Jones, traveled to the Kaibab Plateau to assess its suitability as a breeding ground for cattalo. Jones was convinced that cross breeding buffalo bulls with Galloway cows would produce a sturdy hybrid that would be much in demand for its meat and hides. Ernest Pratt, son of the Kaibab Forest Supervisor, and E.D. Wooley took Jones on a tour of the Kaibab country. Jones' enthusiasm apparently caught hold, for Pratt and Wooley decided to join forces with him. Wooley agreed to acquire stock in the company in exchange for some of his own heifers, which could then be traded for Galloway cows. In addition to cattalo, the three men decided to try their hand at breeding Persian sheep (Easton and Brown 1961:133). Jones managed to persuade two experienced Texas buffalo handlers named James T. "Jimmy" Owens and Frank Anscott, to move to the Strip and manage the herd for him.

On January 8, 1906, Jones received a special federal permit to fence a large area on the Kaibab for the buffalo experiment. In a letter to the Secretary of the Interior dated January 3, 1906, James Wilson, Secretary of Agriculture, explained that the Government would retain a "certain percentage of the produce" in exchange for permitting the use of forest lands (Easton and Brown 1961:135). Six months later, the first carload of 30 buffalo arrived at the train depot in Lund, Utah. After a difficult drive through southern Utah and along the Arizona Road, the herd arrived on the Kaibab; a second herd joined them a few months later.

The buffalo were initially pastured on Bright Angel point. The Kaibab Plateau, as it turned out, was not well suited for breeding purposes; the buffalo preferred the lower and more open terrain east of House Rock Valley (Hughes 1978:77). Although the circumstances that led to Saunders involvement with the company are unclear, the grazing of buffalo on "his" House Rock Valley range probably had something to with it.

It soon became apparent that crossbreeding cattle and buffalo was far more complicated than the company founders had envisioned. One problem concerned the persistence of the hump in the fetus, which made delivery difficult; another problem involved sterility in the hybrids. These unforeseen complications required intensive management of the herds (Easton and Brown 1961:141). Unable to sustain the necessary effort, the company (which had never been formally incorporated) disbanded around 1908, and the stock was divided among the partners. Anscott took the Galloway cattle, E.D. Wooley acquired the persian sheep, and Owens, Wooley and Saunders divided the buffalo. Owens later bought out Wooley and Saunders, and managed the herd on his own (Easton and Brown 1961:141).

On October 1, 1907, a group of California investors filed a notice of incorporation with the Coconino County Recorders Office under the name of the Grand Canyon Cattle Company Coconino Sun, April 10, 1908. Apparently, negotiations were already underway with Saunders to purchase his holdings on the Arizona Strip, for by December 1907 Saunders had signed off on the deed to all of his property and water rights in the area (Gery and Smith 1915: Appendix, 64-74). Like its predecessor, the Grand Canyon Cattle Co. was locally referred to as the Bar Z outfit. The name referred to the company's distinctive brand, which originally had been introduced on the range by Saunders (Reilly 1978:395). The Bar Z outfit gained control of all the range south from Jacob's Pools to the rim of the Grand Canyon, west to the vicinity of South Big Springs, north to Jacobs Lake, and across the head of House Rock Valley to the western edge of the Paria Plateau. Altogether this amounted to approximately 1750 square miles (Gery and Smith 1915:6).

The Bar Z was surrounded on the north, east, and west by a number of smaller ranching outfits. James Emett controlled the range east from Emett Spring to Lees Ferry, and Jacob Hamblin's descendants ran cattle and horses in the sandhills to the northwest. Sheep and cattle belonging to various ranchers from Kanab and Fredonia grazed the western half of the Kaibab Plateau over to Kanab Canyon, while the territory between Kanab Creek and the Hurricane Cliffs was largely the domain of sheep and cattle ranchers from Kanab, Moccasin, and Short Creek.

Around the turn of the century, a bitter feud developed between the foreman of the Bar Z outfit, Charles Dimmick, and James Emett, which eventually resulted in the construction of the first major drift fence on the Arizona Strip. In 1906 or thereabouts, the Bar Z outfit constructed a barbed wire fence from the base of the Paria Plateau near Jacob's Pools to the head of North Canyon, a distance of approximately seven miles. Construction of the fence was necessitated by Emett's apparent propensity for ignoring Bar Z range rights and stealing their cattle. Although the Bar Z cowboys were unable to catch Emett red handed, the circumstantial evidence was quite convincing. According to Rowland Rider, a cowboy for the Bar Z outfit between 1907 and 1917, Emmett had acquired most of his original stock as payment from emigrants crossing on the ferry, and his herds consequently included of a motley assortment of "scrub cattle" (Rider and Paulsen 1979:47). The Bar Z ranch, in contrast, maintained relatively high grade stock, the result of a careful breeding program with several valuable imported Hereford bulls. The Bar Z cowboys became increasingly suspicious of Emett's activities when his herds became dominated by white-face cattle "that were just about as good and looked about as good and were the same breed as the Bar Z stock" (Rider and Paulsen 1979:47).

The Bar Z filed a formal complaint against Emett for cattle rustling in 1906. A trial was held in the Flagstaff county courthouse in April, 1907, but Emett was acquitted for lack of sufficient evidence (Rusho and Crampton 1981:58). The Grand Canyon Cattle Company then tried to buy Emett out, but Emett refused to sell. Finally, the company approached the LDS Church with an offer to buy Lee's Ferry. Acquisition of the ferry by the Bar Z outfit would not only remove Emett's primary source of livelihood, but would also ensure continued access to the western cattle market via the railroad depot at Flagstaff (Reilly 1978:397). The Church accepted the offer, and the sale was consumated on August 18, 1909 (Coconino County Recorder, Deed Book 355:285). After the Church sold the ferry, Emett had little choice but to sell his ranch, and on September 11, 1909, the deed was transferred (Coconino County Recorder, Deed Book 355:286). In June of the following year, the Grand Canyon Cattle Company sold the ferry to Coconino County, but the Lonely Dell Ranch remained the property of the Grand Canyon Cattle Company until 1924, when the company moved out of the Strip.

Although Emett was the Bar Z outfit's primary antagonist, he was not the only one. Disputes also arose with the numerous small ranching outfits that grazed the western side of the Kaibab Plateau. In the winter of 1908-1909, a conference was held in Kanab with local and district forest representatives and the cattle permittees of the Kaibab for the purpose of adjusting an ongoing range dispute. According to Will Mace (1940:2p), who was a forest ranger on the North Kaibab during this period, the small owners, whose combined permits totaled around 6,000 cattle and horses, were upset that their permit numbers were being held down. The Forest Service claimed that this was necessary because of the overgrazed condition of the west side rangelands, but the west side ranchers maintained that the overgrazing was directly traceable to the heavy drift of the Bar Z stock from the east. Mace (1940:2p) summarized the outcome of that meeting.

> At the conference it was agreed that the only way to successfully cope with the problem was to divide the range by constructing a fence. It was agreed that the fence must run generally parallel to the main backbone of the plateau but to include certain portions of the west slope. However, it must cross all canyons in such a way that there would be a natural drift from high to low range for the Bar Z stock and thus avoid traps where they might get snowbound in late fall. Water was a paramount issue and it was stipulated that the location must leave designated ponds or springs on the east side and certain other watering places on the west side. The agreement further stipulated that the Forest Service would furnish the necessary barbed wire and staples to be delivered at Maryvale, Utah, the nearest railroad point; the group of small permittees were to deliver this material at designated points adjacent to the proposed fenceline while the Bar Z outfit, through its superintendent, was to do all construction work and maintain the fence in good condition for a period of five years.

It was the local forest rangers' responsibility to blaze the line for the proposed fence. This work, initiated in June, 1909, was the first range control project to be initiated by the Forest Service on the Strip (Mace 1940:2p). The fence ran on a line from South Big Springs, which was then part of the Forest Reserve but is now in the Grand Canyon National Park, north to Dry Park, Oquer Lake, Snipe Lake, halfway between Three Lakes and Franks Lake, and on to Orderville Canyon near Jacob Lake (Prevy 1967:2). Today, the separation between the Bar Z range and the smaller sheep and cattle outfits is reflected in the distribution of grafitti dating to the teens and twenties carved on aspen trees across the Kaibab Plateau: the names of Bar Z cowboys (often accompanied by the Bar Z brand) dominate the southern and eastern portions of the plateau, while the names of local sheepherds and cattle ranchers are commonly found north and west of the Dry Park area (Fairley et al. 1984:81-82).

The imposition of permit restrictions and grazing fees during the second decade of the 1900s limited expansion of the Bar Z operations. In addition, homesteaders began moving into House Rock Valley and developing new water sources, putting an additional squeeze on the already overextended grazing resources. Then, in the early 1920s, there was a severe drought, and cattle died by the hundreds (Rider and Paulsen 1979:28-29). At that point, the company decided it had had enough. In 1924, the Bar Z moved its remaining cattle to New Mexico. The water rights and ranch facilities were sold to D.E. Wooley of Kanab, a prominent member of the LDS Church hierarchy.

Farming and Homesteading

Agriculture has never been central to the regional economy of the Arizona Strip. Although some exchange of farm produce at the regional level did occur, especially during the 1870s when the United Order movement was still viable, most farming was conducted to meet individual family subsistence needs. The development of organized farming communities so typical of southern Utah was restricted by the near lack of live streams suitable for large-scale irrigation. Instead, the Mormons followed the traditional Paiute pattern, establishing family farmsteads at scattered locations along the base of the Vermilion Cliffs and the western flank of the Kaibab Plateau, wherever springs issued forth with sufficient water to irrigate several acres.

Dugouts and cabins were built at Pipe Springs and Mocassion by 1865, but little if any cultivation took place at these locations prior to 1870. After that date, these and several other springs became the focus of small-scale farming ventures (see Figure 46) (Lavender 1984; Robinson 1970). Nail Canyon, with its numerous snow-fed springs, was one of the more attractive areas for farming on the Arizona Strip and was one of the earliest outlying areas to be settled for this purpose. Nail Canyon was originally called Stewart's Canyon, after Levi Stewart and his son, both of whom established summer ranches there around 1870-1871 (Cleland and Brooks 1983:159). Like many ranching operations of that period, the Stewarts combined farming with livestock raising. Stephen V. Jones, a member of the 1871-1872 Powell survey, recorded the extent of development at Mangum Springs in July, 1872. "Three miles up Stewart's Canon [we] came to the houses of John Stewart and Almon [Ammon] Tenney who have a herd of stock and are farming a little" (Gregory 1948-1949:139). These ranches were subsequently taken over by the Nagel brothers, sons of a prominent winemaker from Toquerville (Granger 1960). (Nagel is the German word for "Nail", thus the canyon's later name). The main drawback to farming in Nail Canyon was the restricted amount and linear distribution of the arable land. When Sharlot Hall passed through Nail Canyon in 1911, she came upon "a field of alfalfa and oats a mile or two long and a hundred yards wide like the fields of Arkansas, where the farmer carries his grub and blankets on the plow and runs a furrow down one day and back the next" (Hall 1975:67).

A major farming effort was initiated at Moccasin around 1875. In that year, Lewis Allen joined the United Order of Orderville and contributed his Moccasin claim to the cooperative. Allen reportedly claimed two-thirds of the spring water, the remaining third being owned by the Winsor Castle Stock Company. A former colonist from the Muddy River, Allen first visited the springs in 1870, while en route to a new home in Long Valley. As was customary in those times, the caravan of colonists stopped at the springs long enough to plant some crops for the benefit of those who would follow (Sandage 1974:190). After the OUO acquired the Moccasin ranch, a large farming operation was developed there. Emma C. Seegmiller, a member of the OUO as a young girl, called the ranch "a Mecca of desires in the way of good things to eat" (1939:180). The Dixie-like climate produced an abundance of peaches, plums, and grapes, in addition to a large crop of melons. The OUO also cultivated fields of sorghum, which the members converted into molasses (Seegmiller 1939:180).

Prior to 1885, when the community of Fredonia was founded, the settlement of Beaver Dams was the only agricultural enterprise on the Arizona Strip that came close to approximating the Mormon ideal of an intergrated farming community based on a communally operated irrigation system. As noted previously, the original settlement of Millersburg was destroyed by flood in 1867. The site remained unoccupied until 1875, when a man named Marshall moved to the area. Three years later, he was joined by three Santa Clara men: J. Graff, Christian Stucki, and Henry Frehner (Larson 1961:167). Like the earlier colonists, the four men irrigated fields on the right bank of the Virgin river with water from Beaver Dam Creek. Sometime prior to 1885, Graff and Stucki married and moved about a mile downstream from the mouth of the creek, where several springs issued forth from bluffs on both side of the Virgin River (Cox and Russell 1973:15). These two farmsteads formed the nucleus of the hamlet called Littlefield. This little farming community has never been able to grow much, due mainly to the limited amount of water available for irrigation (Larson 1961:167). In the early 1900s, an attempt was made to dam the Virgin River about six miles upstream from the town, but the project died when the partially built dam was destroyed by a flood (Larson 1961:168). Two subsequent attempts at damming the river (the last one around 1935) reportedly met similar endings (Richard Malcolmson, personal communication 1987).

The history of settlement along the lower Virgin River illustrates the serious limitation to irrigation farming posed by periodic flooding, and this is equally true of the other major drainages on the Arizona Strip. Efforts at farming on the lower Paria River were even less successful than on the lower Virgin, due to the catastrophic floods that repeatedly destroyed the dams and flumes so diligently constructed by John D. Lee, Warren Marshall Johnson, and later settlers (Reilly 1977). Floods on Kanab Creek have had similar destructive consequences from time to time. Nevertheless, there was at least one major flooding event on Kanab Creek that ultimately had a beneficial effect for farming enterprises on the Arizona Strip.

The town of Fredonia owes its existence to a catastrophic flood that swept down Kanab Canyon in July 1883 (Reilly 1978; see also Robinson 1970:477). Prior to this event, Kanab Creek was a narrow, willow-lined brook that flowed across the floodplain in a shallow channel and disappeared into a thick gravel deposit a short distance below the town. The flood scoured out a huge arroyo in the alluvium and swept the old gravel deposit away, dropping the level of the streambed by several meters. In order to be able to irrigate their fields again, the men of Kanab had to build a dam across the canyon upsteam from the town and bring the water down to the fields in ditches. Shortly after the dam was completed, however, a stream of water issued from the creek bottom and flowed downstream through the Gap in the Shinarump Cliffs (Robinson 1970:477). Several Kanab residents were quick to recognize the potential for developing new farmlands with this water bonus and soon took steps to organize their labor towards this end. On March 24, 1884, six men met at the house of A.W. Brown and agreed to form a water company. As a first step, they decided to build a new reservoir below the Gap (Judd n.d.). Work commenced that spring; by the fall of 1885, the reservoir was completed and several fields were planted with squash and grain (Judd 1975:1). On September 11, 1885, the company shareholders, now numbering seven, met to select a name for the new enterprise and its associated fields. By a vote of six to one, they chose "Stewart" (Judd n.d.). In addition, they decided to raise the membership limit of the Stewart Company to 21, each of the current shareholders being allowed to select two new members each. A few weeks later, the Stewart Company asked two local community leaders, D.E. Wooley, President of the Kanab Stake, and Bishop Robinson, to select a suitable location for the proposed town of Stewart. Wooley and Robinson staked the tithing lot corners in early October. On October 27, company members divided the townsite, which was located north of the reservoir, into 21 rectangular 10 acre lots; the fields, situated to the south, were similarly divided. The following February, the members drew lots for the land, and each man acquired a townplot and a field. Later that year, ditches were put in, parcels were fenced, and construction began on several homes.

During the fall of 1885, Thomas Dobson built a cabin below the townsite to keep an eye on the company's interests. In 1886, Henry J. Hort erected the first cabin within the town boundaries. Thomas P. Jensen completed his house a short while later (Judd 1975:1). Lumber for these structures came from the Stewart mill on Buckskin Mountain (Judd 1975:2).

During the late 1880s, the federal government renewed its campaign to abolish the Mormon tradition of plural marriage. The anti-polygamy effort was prompted by an 1885 Supreme Court ruling, upholding the constitutionality of the 1882 Edmunds Act permitting the disenfranchisement of practicing polygamists. Since enforcement of the act was largely in the hands of federal marshalls operating out of Utah, the Arizona Strip offered a convenient refuge for "cohabs." Several polygamists moved their "extra" families across the border during this period. The communities of Pipe Springs, Littlefield, and Stewart acquired several new residents at this time (Larson 1961:168; Lavender 1984:37).

The little community of Stewart was particularly convenient for the polygamous families of Kanab, being situated only eight miles south and less than a mile across the Arizona line. At the suggestion of Apostle Erastus Snow, the community of Stewart changed its name to Fredonia sometime in 1888 (Judd 1975:2). According to local folklore, the name Fredonia was a contraction of the words, "free" and the Spanish word, dona, (meaning woman) and referred to the freedom from persecution enjoyed by the polygamist wives who resided in the community during this period. In light of the fact that President Snow and many of early settlers of Kanab were of English descent, however, it is possible that the name was originally selected to commemorate a community by the same name in England.

When Sharlot Hall visited Fredonia in 1911, she was clearly impressed by the productivity and charm of this little northern Arizona farming village.

> Everything grows in this bright colored soil and the streets are lined with ditches which distribute the water brought from Kanab Creek through a canal several miles long. The frame houses are built like cottages in an eastern village and each one has its garden and fruit trees and flowers in bloom. . . . The fields of alfalfa and grain lie outside the town along the bit of level valley and are dotted over with haystacks, showing that crops have been good. Almost evey one of the home lots has a big barn at the back full of fresh hay and the whole place looks thrifty [Hall 1975:64].

In 1914, the Arizon Agricultural Experiment Station sent a group of agriculturalists to the Arizona Strip to assess the agricultural qualities of the region. This reconnaissance seems to have been motivated by the Arizona governor's desire to attract more people to this underpopulated region and thereby discourage the State of Utah from pursuing attempts to annex the Arizona Strip (Crampton 1975:6). In a report submitted to the State legislator upon their return, the participants lavished praise upon the agricultural potential of the region. Although they admitted that there was little land of agricultural value east of House Rock Valley, except at Lees Ferry, they described House Rock Valley as containing "the finest of agricultural soils," which could be "easily put under cultivation" (McOmie et al. 1915:14). In particular, McOmie targeted the land from Pipe Spring Valley south through Antelope Valley as an "extensive stretch of very valuable agricultural land" and noted that crops in the Short Creek area proved its productivity (McOmie et al. 1915:15). McOmie concluded that the Arizona Strip was a very fertile area with good agricultural land amounting to almost one million acres, and if the area had more water, it could easily support a much larger population.

Although clearly biased, McOmie's glowing account of the agricultural potential of the region was not entirely unfounded. Between 1906 and 1920, the Arizona Strip was blessed with above average precipitation (see Chapter 2, this volume). Under these aberrent conditions, the once denuded grasslands grew lushly, and some intermittent ponds held water year round (Belshaw 1978:371). Given these circumstances, it is little wonder that McOmie and his colleagues, being unfamiliar with normal climatic patterns in the area, considered the agricultural potential of the Strip to be underdeveloped.

Prior to the publication of the McOmie report, a few men had tested the feasibility of dry farming on the Arizona Strip. Experimentation with dry farming had been encouraged by passage of the Enlarged Homestead Act of 1909, which allowed homesteads claim of 320 acres in areas potentially suitable for farming without irrigation (Lee 1962:234). Under the terms of this act, Frank Brown and his brother homesteaded 320 acres apiece in White Sage Valley south of Fredonia in 1911 (McOmie et al. 1915:26). Sharlot Hall encountered the two farmers there that summer, and noted that they had "good crops of corn and potatoes growing, without water for house use ever, and without rain so far this year" (Hall 1975:67). In 1914, they had some 100 acres under cultivation. They planted Turkey Red wheat in the fall of 1913 and harvested about 20 bushels per acre in the summer of 1914 (McOmie et al. 1915:26). In addition to wheat, they grew corn and beans. The Browns claimed to be the original dry land farmers in the area.

The passage of the Homestead Dry Farming Act in 1909 was largely responsible for the development of the only other important farming communities on the Strip: Short Creek (Colorado City). At the outset, Short Creek was just another isolated farmstead. Sometime in the early 1900s, Frank Johnson established himself on the site of the old Maxwell Ranch (Lauritzen 1951:16). Passage of the Dry Farming Act encouraged other farmers to take up claims in the area. Among those who moved to the area around 1910 were Jacob Lauritzen and David Rust (House 1986:30; Malach 1981:45). Lauritzen and Rust made plans to pipe the water from Maxwell Spring down to their homes at the mouth of the canyon, but lack of funding forced them to abandon this scheme. Rust later moved to Kanab, where he became involved with the fledgling tourist trade (see discussion on recreation below), but Lauritzen carried on and was later joined by other families.

Elizabeth Lauritzen described her grandfather's efforts during those initial years at Short Creek.

> [W]ater was brought down in a ditch with flumes made from hauled from the Mount Trumbull area some fifty miles to the south. Jacob Lauritzen, with the help of his boys, then cleared and farmed the land, built a house and fences, planted an orchard, and raised pigs and cattle. They had fifty heifers on the range and did their work with horses. They hauled lumber from Mount Trumbull for a house and for boarding up tents for sleeping quarters for the boys [Malach 1981:45].

By 1914, there were approximately 50 people living and around the Short Creek area (McOmie et al. 1915:18). Included among the farmers of that period were the Johnson brothers, Frank and Price. Although the LDS Church had long since renounced the practice of polygamy, the Johnson brothers carried on the tradition of their forefathers. Over the years, other practitioners of plural marriage joined the Johnsons at Short Creek, and the community acquired a reputation as a haven for polygamists. Many years later, the community gained a certain notoriety when Arizona county and state law officers staged a series of raids on the town. The first raid occurred in 1935; other raids followed in 1944 and 1953 (House 1986:30). Although most current descriptions of Colorado City, as the community of Short Creek is now called, seem to center on the polygamist tradition of the town, it is important to bear in mind that the community was, and continues to be, primarily a rural agricultural settlement that conforms to most of the traditional ideals of the typical Mormon settlement (Francaviglia 1970).

McOmie's glowing account of the agricultural potential of this area, in conjunction with the passage of the 1916 Stock Raising Homestead Act, encouraged other settlers to enter the region and try their luck at dry farming. The 1916 Stock Raising Homestead Act permitted homestead claims of 640 acres in areas classified by the General Land Office as suitable primarily for grazing. Coinciding with the passage of the Stock Raising Homestead, in 1916 President Woodrow Wilson released large sections of unproductive forest lands to homestead entry. Among the lands released were 588,520 acres of Dixie National Forest, including the entire Parashont Division and a large portion of the Mount Trumbull Division.

In the late teens and early twenties, families by the name of Graham, Cunningham, Iverson, Schumtz, Esplin, Waring, Wiggins and several others homesteaded these former forest lands (Belshaw 1978; Cox and Russell 1973; Malach 1975). The story of Bob and Fern Kenworthy, who homesteaded on the flanks of Mount Trumbull in the 1920s, provides a representative example of life on this twentieth century frontier. Bob Kenworthy established his claim in 1921 (Cox and Russell 1973:185). Along with Irvin Bryner, he cleared a mile-long stretch of sage, built a dugout, fenced a small clearing, and planted turnips and alfalfa. The first year they raised a successful crop of turnips and the following year, they raised 20 tons of oat hay and had 600 bushels of wheat. By the mid 1930s, the Kenworthy's had built a small house on the property. In her recollections of this period, Fern Kenworthy remembered both the successes and failures they endured.

> Mal Terry and his family homesteaded five miles east of us and joined in building ponds and fences with us. Bob made a big hay and machine shed and covered it with galvanized iron, with a trough and down pipe to carry the accumulated dew into a barrel. That supplied us with house water. The men made a nice cellar, with shelves for our winter supplies. We raised corn, melons, peas, potatoes and beans. And we

> had chickens, pigs and turkeys. This was in 1937. Sadly enough, however, next year thirty acres of corns, beans and squash froze [Cox and Russell 1973:185].

Not all homestead entries on the Strip were filed for valid reasons. Invariably, there were those who manipulated the law for private gain. A case in point was Ed Johnson, who filed on the section surrounding the old Parashont Ranger Station. Johnson was a Texas cowboy with a shady past who was employed by Preston Nutter. As soon as he proved up his claim, Johnson turned around and sold it to Nutter (Belshaw and Peplow 1978:II 34,35). Nutter subsequently used it as another base of operations for his widespread cattle business.

In some cases, new settlements were formed by groups of homesteaders laying claim to contiguous parcels of land. The community of Bundyville is the oldest and probably best known example of this type of settlement pattern. In 1916, Abraham Bundy and his son Roy, filed on 320 acres apiece west of the Hurricane Cliffs, in an area known as Cactus Flats. A resident of Littlefield, Arizona, Abraham Bundy had become familiar with the area while hauling ore from the Copper Mountain Mine to St. Thomas (Belshaw 1978:371; see discussion on mining below). The Bundy's were apparently unaware of the terms of the Homestead Stock Raising Act when they initially filed their claims, but the following year, they enlarged their homesteads to one section apiece (Cox and Russell 1973:5-6).

Like most previous settlers on the Strip, the Bundy families first built dugouts to live in; only after crops had been planted and the fields fenced did they turn their attention to building more permanent houses (Cox and Russel 1973:34). Lumber for fence posts and structures came from the Blake mill on Mount Trumbull (Cox and Russel 1973:41).

Two more families joined the original dozen settlers during the following year, bringing the population to 31 residents. The residents chose the name Mount Trumbull for their little settlement, but the community became locally known as Bundyville (Cox and Russel 1973:46).

In 1918, a one room school house opened with 11 children in attendance (Cox and Russel 1973:46). The school house served double duty as a church and meeting house. As noted by Belshaw (1978:373), this school house chapel, centrally located at the intersection of the Mount Trumbull Road and Main Street, was the only aspect of the settlement that could be considered typically Mormon. Other characteristic features of pioneer Mormon communities, such as wide streets, steet side irrigation ditches, hay derricks, brick construction, and "Mormon fences" (Francaviglia 1970) were lacking. Belshaw cited some of the obvious reasons for these discrepancies.

> No irrigation water runs down streets side ditches, for there are no streets and there is no water. Houses in Bundyville are one story, principally of adobe, with shingled hip roofs. Fired bricks, dual chimneys and architectural elaboration are nonexistent. The landscape is open, but not as in the prototype communities where houses were clustered and farmers commuted daily to their fields. In Bundyville only the school and teacherage are at the center. All other houses are widely scattered, and for reasons which are not difficult to understand. Under the homestead law more than half time residence on the site is required. Few homesteaders could keep two homes and therefore had to live on their claims [Belshaw 1978:373].

Other "homestead communities" that sprang up on the Strip in late teens and twenties include Tuweep in the Toroweap Valley east of Mount Trumbull, Little Tank in the Main Street Valley, and Wolf Hole.

The Canebeds area was also taken up by homesteaders during this period. The water rights to major springs in this area had long been claimed by cattlemen (Gery and Smith 1915), and the Grand Canyon Cattle Company maintained a ranch at the mouth of the canyon, but the surrounding range lands remained in the public domain (Malach 1979:21). Beginning around 1913, homesteaders began filing claims in the area below the ranch (Malach 1979:27). They dug shallow wells, built fences and cabins, and put in crops that would grow without irrigation: corn and rye for livestock feed, and potatoes, melons, beans, and various vegetables (Malach 1979:25-27).

Finding themselves increasingly hemmed in by settlers, the Bar Z outfit sold its Canebeds ranch to Frank Ballard around 1916 and moved their cattle to House Rock Valley. It was not long before cattlemen and homesteaders started to infringe on the House Rock Valley range as well. Among the cattlemen moving into the area at this time were D.E. Wooley, Jet Johnson, Walt Hamblin, and a man named Brown (Wright 1972:16). Alex Cram dug a well east of the Kane Springs Ranch, and W.J. Mackleprang developed the "Bean Hole" upstream from Cram's Well. By the mid 1920s, increased competition for the range, in combination with drought and the implementation of Forest Service grazing fees, had forced the Grand Canyon Cattle Company to sell its holdings and move off the Arizona Strip. After the Bar Z outfit left the area, its holdings in the northern part of the valley were acquired by several smaller ranching families including the Nelsons, Parkers, and Schoppmans.

Lumbering

During the early decades of settlement on the Strip, the timber resources of the region were exploited only on a limited basis, with local stands of Ponderosa pine providing materials for construction of cabins, homesteads, and church-financed building projects. Although it was not until the mid-twentieth century that large scale and economically significant lumbering began, it was during the 1870s that the first sawmills were established in the two areas that were later to become centers of the timber industry on the Strip--the Mount Trumbull region and the Kaibab Plateau.

In 1871, Brigham Young instructed Robert Gardner, an early settler in the St. George area, to establish a sawmill on Mount Trumbull for the purpose of supplying lumber for the LDS temple at St. George (Larson 1961:586-587; Hafen 1965:18-19). In 1872, two church-owned sawmills began processing the timber, which was hauled to the temple site in St. George over a rough wagon road later known as the Temple Trail. The Church operations used "large steam boilers and flues to generate power for the mills . . . [with] water . . . sluices down from Nixon Springs, not far from the summit of Mount Trumbull" (Hunt 1978:240). James W. Nixon was called to take over operations in 1876, and eventually a small settlement grew around the mill site. This settlment included a large boarding house and four bunk houses (Cox and Russel 1973:11). Once the temple had been dedicated, the church turned operation of the mill over to Nixon.

As noted previously, the first known sawmill on the Kaibab was set up at Levi Stewart's ranch at Big Springs in 1871. This was the same mill that John D. Lee had operated at Skutumpah the year before. Stewart's steam-operated mill was moved a mile south to Castle Springs a few years later but by 1878, when the geologist Clarence Dutton passed through the area, this site was already abandoned (Dutton 1882:131). Apparently, the mill was subsequently transferred to the Riggs Springs area (Woodbury 1944:190).

Another mill was erected at Jacob Lake in the late 1870s or early 1880s (Wilson 1941). In 1901, John Franklin Brown purchased the Jacob Lake mill from Hiram Bradford Shumway. When the Forest Service began active management of the Kaibab Plateau in the early 1900s, the Jacob Lake mill was reported to be the only one operating within the forest boundaries (Lang and Stewart 1910:5). After the Jacob Lake mill burned in 1911 or 1912 (Hall 1975), Brown bought a new mill and worked in LeFevre Canyon. Another early milling operation was established on Mount Bangs (formerly known as Hancock Peak) around the turn of the century by settlers from the Littlefield Mesquite area (Richard Malcolmson, personal communiction 1987). During the summer and fall, ponderosa pines were harvested from the slopes of the mountain and hauled to the edge of the escarpment overlooking Hancock Canyon, where the logs were stockpiled. In the winter, the logs were skidded down approximately 2,800 feet of snow-packed wooden chutes to a steam-powered sawmill at Hancock Spring. Many of the homes and outbuildings in Littlefield, Mesquite and Bunkerville were built with this lumber, and a number of these buildings are still standing. Parts of the sawmill are still visible at the spring, which is now included within the boundaries of the Paiute Wilderness Area (Richard Malcolmson, personal communication 1987).

All of these early timbering operations were generally similar to one another in that they were steam-powered and labor- intensive. The mill crews generally consisted of six to eight men. A crew would spend several weeks logging in the spring, and after enough logs sufficient to last the mill a few weeks had been stockpiled, sawing would commence. Thus, the same crew alternated between logging and sawing throughout the summer (Lang and Stewart 1910:14). The steam-powered engines required that the mills be set up close to major springs or reservoirs. As timber resources declined in the vicinity, the mills were dismantled and moved to more promising locations. Anything usable was moved along with the mill, and even the buildings were dismantled. This explains why rock or concrete foundations and sparse trash are usually the only remains found at the sites of these former operations.

Timbering continued on a modest scale throughout the early 1900s and was economically significant only on a local level. Mills were located in the same general areas that had been the focus of earlier timbering. Around 1911, the Dixie National Forest conducted a survey of the timber resources around Mount Trumbull. At that time, the Dixie had jurisdiction over two parcels of forest land on the Arizona Strip: the Trumbull Division and the Parashont Division. The survey estimated that there were 60 million board feet of timber on Mount Trumbull and another 22 million board feet in the Parashont Division (Washington County News, July 20, 1911). The United States Forest Service actively promoted these timber resources, and in 1913, two mills with a daily capacity of 4,000 board feet were established on Mount Trumbull (Hinton 1987:84). One mill was set up by Ben and Fred Blake north of the summit of Mount Logan, and shortly thereafter, Frank Petty began lumbering south of Trumbull (Cox and Russell 1973:11; Hunt 1978:242). Later a man named Stout took over the Petty's mill and moved it farther south (Cox and Russel 1973:11).

Elsewhere, William Judd operated a mill at Little Mountain in the early 1920s. During the period between 1926 and 1944, sawmills owned and operated by Glen Johnson and the Heaton family operated in the West Lake, Mile and a Half Canyon, and Johnson Sawmill Canyon areas. All these mills burned and were never rebuilt (Prevy 1967:2).

Up until the 1940s, the lumber industry on the Arizona Strip remained in the hands of a few entrepeneurs who operated small- scale, locally oriented enterprises employing an insignificant number of local residents. In the mid-1940s, this situation began to change. The war effort demanded large quantities of timber for crates, barracks, air hangers, paper, and a myriad of other purposes (Abott and Henderson 1943). With the booming market created by this increased demand for lumber, large-scale exploitation of the North Kaibab timber resources became commercially feasible. In 1944, the Cutler brothers established a mill at Fredonia. The following year, this mill and another one at Jacobs Lake were bought by the Whiting Brothers, a family- owned lumber company from St. Johns, Arizona.

In a sense, it was fitting that the Whiting family should establish the first (and still only) major sawmill operation on the Arizona Strip. In 1876, the Whiting family had been among the first to answer Brigham Young's call and travel over the Arizona Road, en route to the Little Colorado River Valley. On a return trip to Utah in 1882, May Whiting, a sister of Edwin Whiting and aunt of the four Whiting brothers, were buried in House Rock Valley (Hooper and Hooper 1977a:19). Edwin Whiting built a successful career cutting ties for the Santa Fe Railroad when it was still under construction east of Flagstaff, and he later established several mills near St. Johns, but throughout his adult life, he longed to return to northern Arizona and lay claim to the virgin timber on the Kaibab Plateau. Although Whiting was never able to fulfill his life long ambition, his sons managed to do so (Fawcett 1966:8-11).

Initially, the Whiting brothers operated three small mills on the Arizona Strip: one at Fredonia, one at Jacob Lake, and another in House Rock Valley (Fawcett 1966:13). The rough cut lumber had to be transported to Flagstaff for finishing. The post-war economic boom created such a high demand for lumber that the Whiting Brothers decided to invest in a planing mill, which would allow them to ship finished lumber directly to the eastern markets via the Cedar City railroad depot. The new mill opened in September, 1950 (Fawcett 1966:21, 25).

Meanwhile, Kaibab Forest officials had decided to increase the annual timber harvest on the North Kaibab. According to Forest Service estimates, 25,000,000 million board feet could be harvested for an indefinite period of time on a sustained yield basis; this was more than twice the amount produced by the three Whiting Brothers mills combined (Kane County Standard, February 24, 1950). In order to attain this level of output, the Forest Service had to induce a private concern to establish a modern sawmill in the area. To accomplish these ends, Kaibab Forest officials developed a plan to sell 168,000,000 million board feet over a 20-year period. The Big Saddle Timber Sale, as it was called, centered around the Big Spring Ranger Station. As an added incentive, the Forest Service determined to build a $500,000 gravel based road through Nail Canyon (Anonymous 1953b:54). In addition to meeting an annual harvest quota of 25,000,000 board feet, the contract for the Big Saddle Timber Sale required the contractor to have sufficent operating capital to cover the cost of a complete single band sawmill with a daily capacity of 20,000 board feet, a fleet of logging trucks and tractors, and installation of a logging camp and roads (Kane County Standard, September 22, 1950).

Despite the remote location, the sale attracted bids from every major lumber company in the Southwest (Fawcett 1966:25). The Whiting brothers had invested too much money in their new planing mill to let this contract fall into the hands of their competitors. On September 20, 1950, after an intense day of high stakes bidding, the Whiting Brothers managed to secure the contract (Fawcett 1966:24-26). The final bid of $45.10 per thousand board feet was more than 10 times the appraised value, an unheard of price for the times, but it assured the Whiting Brothers of a virtual monopoly on the Kaibab Plateau for years to come (Fawcett 1966:26-27).

Although the company lost $250,000 during the first year, sound management practices, lucrative tax breaks, and a subsequent revision of the original bid price kept them solvent (Fawcett 1966:30-35). In addition, the Whiting Brothers installed an unusual and highly efficient new mill at Fredonia, which helped them to recoup their initial losses within a relatively short time span. The new mill operated two six-foot band saws that ran exclusively on electricity supplied by four diesel-powered generators. It differed from most mills in that all the machinery was placed at ground level overlying a cellar housing the deck equipment. In 1953, it was considered to be one of the largest diesel power mills ever built and one of the most outstanding mills in the entire United States (Anonymous 1953a:54-55). In recognition of the role played by the Kaibab Forest in developing their industry, the Whiting Brothers changed the name of their operation on the Arizona Strip to the Kaibab Lumber Company (Fawcett 1966). Thirty-five years later, the Fredonia mill is still ranked among the top mills in the country and it continues to be a major employer in the area. The story of the Kaibab Lumber Company provides a positive example of how government and private business can work in tandem to benefit each other.

Mining

The first exploitation of minerals on the Arizona Strip occurred in 1872, when two of Powell's packers discovered a little "color" in the sand at the mouth of Kanab Creek. Word of the gold discovery soon reached the outside world via the newly installed telegraph at Pipe Springs, and by early March, miners began pouring into the region from all directions. The gold, as it turned out, was too fine to be profitably exploited, and the rush abated after a few months. Nevertheless, it had a significant impact on the area. This sudden flood of outsiders breached the long established isolation of the Mormon communities and stimulated the local economy to an unprecedented degree. It was also responsible for some of the earliest commercial traffic on the newly established ferry at the mouth of the Paria (Brooks and Cleland 1983:103-105).

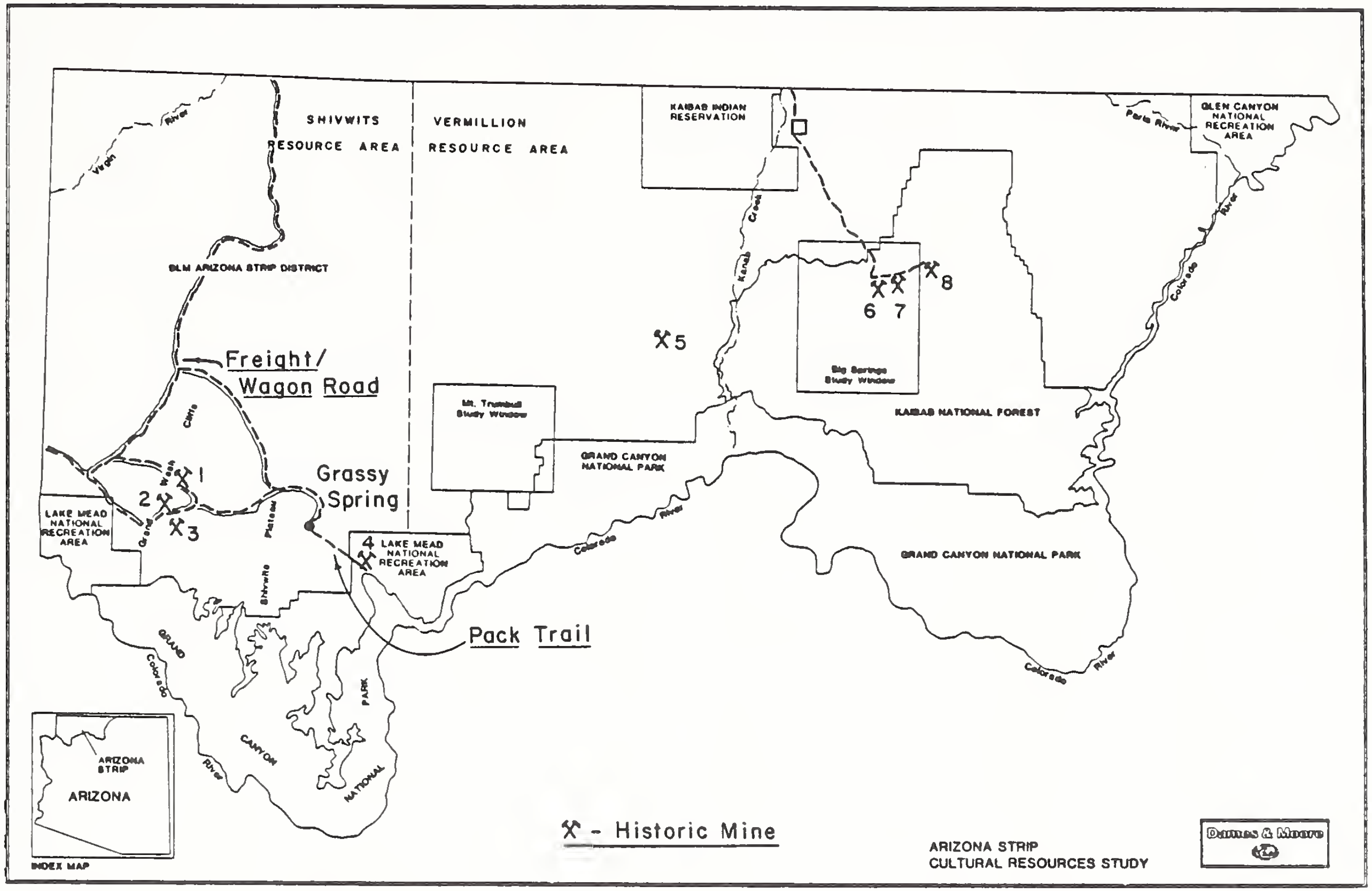
Although gold was never an important commodity on the Arizona Strip, copper proved to be more abundant and was periodically profitable. In the early 1870s, the Bentley Mining District was formed and claims were filed on the Adams Lode, an exceptionally high grade ore deposit, which became the focus of several moderate sized mining operations (Figure 47).

Of the several mines developed in the Bentley district, the most important one was the Grand Gulch Mine. This mine was located on the edge of the Grand Wash Cliffs near the head of Pigeon Canyon. Billingsley (1976a:71), citing Hill (1915:42-43), claims that "the Grand Gulch copper deposits [were] first discovered in 1853 by Richard Bentley, Samuel S. Adams and others." Hill's source was a Mr. Callaway who was a former superintendent at the mine. "According to Mr. Callaway . . . the Grand Gulch ore deposit was discovered about 1853 though it seems certain that it was known to the Indians before that time. The prospect was bought from the Indians for a horse and some flour by a Mr. Adams, employed by Bishop Snow, of St. George, Utah (Hill 1915:42-43)". Hill's information is clearly erroneous, since St. Geroge did not exist until 1861, and Snow did not settle in the area until that date (Larson 1961). A more plausible account is provided by W.P. Jennings, a former manager and part owner of the mine in the early 1900s.

> The Grand Gulch Mine was discovered by a Shiwits [sic] Indian about the year 1871. He made known his discovery to men living at St. George, a small Mormon settlement in the southern part of Utah, about eighty miles north of the discovery. The extreme high grade of the ore excited considerable attention. It was worked in a primitive way for several years. Several attempts were made even to smelt the ore [Jennings 1911:269].

Jennings' account fits with information provided on a Notice of Location, filed at the Phoenix office of the Bureau of Land Management, which shows that the Adams Lode in the Bentley Mining District was officially claimed on June 23, 1873. The claim was signed by Richard Bentley, Samuel S. Adams, Erastus Snow, James Pearce, and eight other men from the St. George area (Belshaw and Peplow 1978:II-26). Profitable exploitation of the ore, said to be "the richest ever produced by a copper mine in the Territory," was hampered by isolation of the mine and the long haul to the nearest railhead (Jennings 1911:296; Malach 1974:127). According to Samuel L. Adams, tools and supplies were initially packed in by mule, and in the early 1870s, a wagon road was opened to St. George (Adams 1955:396). This road apparently went down Pigeon Canyon and connected with the Pierce's Ferry road.

Geologist James M. Hill described the mine as he saw it in November 1913.



1) Grand Gulch
2) Savannic
3) Cunningham
4) Copper Mountain
5) Hack Canyon
6) Ryan (Coconino City)
7) Lambs Lake
8) Jacobs Lake

Figure 47. Historic Mines and Associated Roads.

> [The] camp lies in a small depression and is not visible from a distance. The first view from the road shows a frame engine house, surrounded by dumps and ore houses with two long masonry buildings in the backround. The shaft is equipped with a 22 horse power gasoline hoist, whose engine also operates a 10 by 10 inch air compressor capable of running three drills, and with a crosshead and bucket [Hill 1915:46].

Because of the difficulties involved in hauling large amounts of unprocessed ore over long distances, an adobe smelter was built at the mine around 1878 (Deseret News, May 22, 1878). Apparently, the smelting operation was only partially successful, since the slag heaps were later shipped out for further processing (Hill 1915:43). Remains of the smelter are still visible at the mine site (Belshaw and Peplow 1978:V-2).

Extensions of the San Pedro, Los Angeles, and Salt Lake Railroad during the first decade of the century made it more economical to transport the ore by way of St. Thomas, Nevada, than through St. George. In 1906, a 54-mile-long wagon road connecting the mine and St. Thomas was constructed. Although this wagon road may have been in existence prior to 1906, no records of its earlier use have been found (Belshaw and Peplow 1978:V-3). A detailed description of this road in 1913 is provided by Hill.

> The road crosses Virgin River by a ford 2 miles east of St. Thomas, beyond which an ascent of 1,300 feet in 16 miles along the bottom of a narrow canyon carries it to the summit of Bitter Springs Pass over the Virgin Mountains. The road continues on the south bench of Black Canyon to a point about 2 miles from Grand Wash, which is crossed at either the Willow Spring or the Pakoon Well crossing. For about 6 miles east of the crossing the road passes over the low bench of Grand Wash to the base of the Grand Wash Cliffs, 1,250 feet high, which are ascended by a tortuous but well constructed grade, up a narrow canyon that opens to the north. The mine is about 2 miles south of the place where the road reaches the top of the first line of cliffs, but to avoid a deep canyon a detour of 4 miles is made to reach the mine [Hill 1915:41].

Hill noted that freight teams required a week to make the round trip. Between 8 and 12 tons were hauled on each trip at the rate of $10 a ton. The teams included 6 to 10 horses, and the drivers usually traveled in pairs in order to be able to double up on the steep grades (Hill 1915:41). Most of the freighters were local farmers from the lower Virgin River country (Jennings 1911:269).

Freighting from the Grand Gulch mine continued on a regular basis until the close of World War I. Throughout this period, there was only one attempt to haul ore by truck. In the summer of 1913, a Sauer gasoline truck operated between the mine and the Virgin River, but the experiment was discontinued later that fall due to the poor condition of the road and the cost of maintaining the tires (Hill 1915:41). The drop in copper prices following World War I caused the mine to shut down for two decades; it was reopened for a brief time during and immediately following World War II. During its later phase of operation, trucks were used instead of wagons. The mine closed again in the early 1950s (Malach 1975).

There were several other producing copper mines in the Bently District in addition to the Grand Gulch operation. The Savanic (also called the Bronz L or Bronzell) and the Cunningham mines were both located along the Grand Gulch cliffs. Like Grand Gulch, the Savanic mine contained exceptionally high grade ore, but extraction of the copper was not commercially feasible due to poor access and transportation difficulties. It was apparently acquired by Harry Gentry of St. Thomas around 1910. Gentry reportedly mined 25,000 tons of ore until the price of copper dropped after World War I. Gentry never patented his claim, and the mine was subsequently taken over in 1933 by

Louis R. Lund, who leased it to Willaim E. Rogers of St. George in 1941 (Arizona Department of Mineral Resources 1941).

South of Mount Trumbull, on the bench separating Parashont and Andrus Canyons, there was another mine called Copper Mountain (or Copper King). A claim to this latter property, registered with the Mohave County Recorder's Office by James Andrus, president of the Copper Mountain Mining Company, states that the site was first located in 1875 (Mohave County Mining Records, Book E:373-374, cited in Crampton 1985:151,243). Copper Mountain, which is located within the present boundaries of Lake Mead National Recreation Area, was the only mine on the Arizona Strip to produce a significant quantity of silver (Elsing and Heinemen 1936:96).

Like the other mines in the Bentley District, the profitability of the Copper Mountain mine was limited by its restricted access. The ore had to be packed by out by mules over a difficult seven-mile-long trail to Grassy Springs. From this stockpile location, there were two freight roads. One ran west to connect with the Grand Gulch mine road, while the other one went by way of Pakoon (Belshaw 1979b:8-9). This latter route was apparently used to avoid the steep climb up Grand Gulch (Belshaw 1979b:9).

The 1890s marked the beginning of a copper boom on the Kaibab Plateau and surrounding canyons. The first claim in Warm Springs Canyon was officially recorded on Febuary 5, 1890, by S.W. Taylor, at that time the field manager for John W. Young's Kaibab Land and Cattle Company (Reilly 1978:395ff). Sometime thereafter, the Warm Springs Mining District was organized. This district centered on copper-bearing chert beds exposed in the walls of Warm Springs Canyon and in the vicinty of Jacobs and Lambs Lakes (Jennings 1904). Between 1890 and and the mid-1900s, hundreds of claims were filed in the district by local residents from Fredonia and Kanab, as well as by outside mining interests (Coconino County Mining Claims Books 1-3). Only a few of these claims were ever worked to a significant extent.

The Petoskey Mining Company initiated mining its claims in the area known as Lambs Lake in June 1898 (Coconino County Millsites and Water Rights [CCMS&WR] Book 1:181). On July 21, 1899, the company claimed a 5 acre mill site about one mile up from the mouth of Warm Springs Canyon, surrounding the springs (CCMS&WR Book 1:182) and on February 7, 1900, they filed a Notice of Appropriation on the Warms Springs water, claiming "enough to run two thirty ton smelters" (CCMS&WR Book 1:181). The affidavit stated that the company intended to transport this water through an iron pipe to two other nearby millsites at Lambs Lake. Sometime after this date and prior to 1902, the Petosky Company constructed a steam pumping and leaching plant and lesher, but this plant burned down before any ore could be processed (Lang and Stewart 1910:5; Coker 1978:24).

Aquilla Nebeker was another early miner in the Warm Springs District. Along with co-claimants B.G. Millett, Oliver DeMill, and D.B. Stewart, Nebeker (a resident of Rich County, Utah) filed his first claims with the Coconino County recorder in 1899 (Coconino County Mining Claims Records, Books 3:8,97; 4:88,89 92; 5:79). Nebeker and his partners called themselves the Coconino Copper Company. On August 25, 1900, they filed claim to the Coconino Mill Site at the mouth of Warm Springs Canyon; Nebeker's claim to the adjoining "Coconino Stone Quarry," which was filed on the same date, included a reference to the "Coconino mill site and smelter", indicating that ore processing facilities were already in place at the site by this date (CCMS&WR, Book 1:187). On October 27, 1900, the partners filed a claim on Riggs Spring and Big Spring, stating their intention to pipe the water down Nail Canyon for use at the smelter (CCMS&WR, Book 1:205). The Big Spring supply was subsequently tapped for this purpose (Gery and Smith 1915:15).

In 1901, the Coconino Copper Company located additional claims north of Warm Springs Canyon and built a reverberating furnace at the millsite (James and Button n.d). Due to the high silica content of the ore, the smelting operation had to be abandoned. A leaching plant was subsequently constructed, but it too proved unsuccessful due to the unstable nature of the copper compounds (Coker 1978:24). The smelter was operated by Mr. Timmons, and Charles Dedrick was mining superintendent at the leaching plant (James and Button n.d.).

The company headquarters at the mouth of Warm Springs Canyon was originally known as "Coconino" (Barnes 1935:371) or "Coconino City" (Hall 1975:67). Sometime around 1902, Nebeker sold his mine and the mill facilities to a Mr. Ryan from Michigan, and the camp became known as Ryan (Granger 1983:535; James and Button n.d.). A post office operated at Ryan from February 6, 1902, until July 18, 1902, indicating that a substantial population was in residence during this time (Granger 1983:535). Despite a prosperous appearance, local accounts suggest that the only time the property made any money was when Nebeker sold it, reportedly for $40,000 (James and Button n.d.). The plant must have shut down about the same time as the post office, for a Forest Service document written in 1910 mentions that the plant at Ryan had been closed down for "several years" (Lang and Stewart 1910:5).

An increase in copper prices during World War I renewed interest in the Kaibab deposits for a brief time. In 1916 John Mackin claimed sites known as "Buster," "Ensign," and "Grant," "Hawk," "Pigem," "Sunshine," and "Jumbo" (Coconino County Mining Records, Book 9:62 63, 74 78), and in 1925 and 1926, he claimed an additional six sites in the Warm Springs District (7:554, 9:223 226,227). About 1928, the St. Anthony Copper Company was organized and began mining the Mackin claim group just north of Jacob Lake. The Mackin Mine reportedly produced $25,000 worth of ore in 1929 (Elsing and Heinemen 1936:92). In 1928, the company built a railroad down Warm Spring Canyon to Ryan where a 100 ton blast furnace was constructed. Construction of a tramway also began in 1928, but this project does not appear to have been completed (Coker 1978).

Increased demand for copper during World War II spurred a flurry of interest in Kaibab mines during the 1940s. In 1943, the Mackin and Lamb's Lake deposits were acquired by the Atherly brothers of Fredonia, who operated under the name Apex Mining Company. The Atherlys installed a power shovel and hauled the ore to Marysvale, Utah, from where it went by rail to Salt Lake City. They are reported to have shipped 20,000 tons of 5 percent copper ore between 1943 and 1947 (Dunning and Peplow 1959:365).

Ultimately, transportation problems, weather, and the price of copper all conspired to render mining operations on the Kaibab unprofitable. The present site of Ryan is nothing more than rubble spread along the hillside. Portions of the railroad bed and railroad ties are visible here and near the water storage tank at Warm Springs Canyon (Coker 1978).

Another copper mine on the Arizona Strip, which had a significant impact on later mineral development in the area, was located in the bottom of Hacks Canyon, a major tributary of Kanab Creek. Although the ore deposit was known for a long time, it was not until World War II increased the demand for copper that anybody bothered to develop the site. In the early 1940s, "Blondie" Jensen of Fredonia and G.C. Harwood of Phoenix organized the Canyon Copper Company. They constructed a road to the mine and shipped a few loads of ore in 1944 and 1945. Then, just as the war ended, the road washed out and the mine shut down (Dunning and Peplow 1959:363).

Ironically, World War II stimulated great interest in another element that often co-occurs with copper: uranium. The U2 boom began almost as soon as the first atomic bomb exploded on Japan. During the late 40s, uranium was discovered in the Cockscomb area east of the Kaibab Plateau, setting off a flurry of prospecting throughout the region (James and Button n.d.). The Atomic Energy Commission sent geologists into the area to explore the prospects. These geologists discovered that the copper mineral in the Hacks Canyon mine was torbenite, a uranium-copper compound (Dunning 1948; Rasor 1949). The Hack Canyon Mine reopened for uranium production during the early 1950s, and was one of the first commercial producers of uranium in Arizona (Dunning and Peplow 1959:363).

The Bureau of Land Management

Perhaps no single piece of legislation had as much impact on the federal management of Arizona Strip public lands as the Taylor Grazing Act of 1934. The primary objectives of this long and complicated piece of legislation were (1) "to stop injury to the public grazing lands by preventing overgrazing," (2) "to provide for their orderly use, improvement, and development," and (3) "to stablilize the livestock industry dependent upon the public range" (Calef 1960:53).

A primary provision of the act authorized the Secretary of Interior to organize grazing districts. Once established, the forage within those districts could be leased for a fee. The act specified that permits for grazing in these districts were to be issued on a priority system based on property ownership and previous use of the range. The numbers of animals permitted to each livestock owner would vary in proportion to the amount of land he owned as base property to support his stock during the months when they could not be put on the public range. Nine western states adhered to this plan, but in the case of Arizona and Nevada, the rules were amended so that private water holdings, rather than land, determined the size of each rancher's allotment (Brooks 1949:298). This rule effectively eliminated all grazing by transient sheep herders on the Arizona Strip. It also precluded use of the range by many of the newly established homesteaders in the region, since very few of the recent arrivals had managed to secure land with permanent water. Implementation of the Taylor Grazing Act was a major cause of the abandonment of homesteads on the Strip during the late 1930s (Belshaw 1978:374).

Another provision of the act authorized the Secretary to classify lands according to their most appropriate use and to dispose of lands most suitable for homesteading or other non-grazing purposes. This provision was interpreted to mean that the Secretary also had the right to refuse homestead entry on lands that were not well suited for agriculture (Clawson 1971:77). By the 1930s, there was little land remaining on the Strip that could be considered suitable for dry farming; hence, the act had the effect of closing the Strip to additional homestead claims.

In order to implement the provisions of the Taylor Grazing Act, the Division of Grazing was organized within the Department of Interior, and regional offices were opened in Arizona and seven other western states. In 1939, the Division of Grazing was reorganized as the Grazing Service, but its essential functions remained unchanged (Calef 1960:76-77).

The Arizona Strip District was the first grazing district organized within the State of Arizona (Wright 1972:1). The first meeting of the local Advisory Board occurred at Zion National Park on July 26, 1935. Representatives from virtually all of the principal sheep and cattle owning families on Strip attended this meeting. The sheepmen included C. Lamoreaux, R. Atkin, J.C. Muller, A. Findlay, S. Brown, C. Pugh, C.C. Anderson, L. Cox and E.L. Childers; cattlemen included R.B. Wooley, D. Judd, J.H. Schmutz, F.C. Heaton, R.U. Chamberlain, W.B. Mathis, H. Reber, J.F. Findlay and L. Foremaster. C. Alcorn was the only goat owner present (Wright 1972:1). Notably absent from the meeting was Preston Nutter, one of the principal advisors to the drafters of the Taylor Grazing Act. In ill health, Nutter died the following year (Price and Darby 1964:251).

By March of the following year, 172 year-long grazing permits were issued for 18,890 cattle and horses and 26,482 sheep and goats. Another 43 winter-use permits were issued for 123 horses and cattle and 31,627 sheep and goats. The latter permits were for grazing in the Pakoon, Grand Gulch, and Main Street areas. The grazing fee was intially set at 5 cents per animal unit month (Wright 1972:1-2).

The fledgling Division of Grazing was charged with administering a huge area. The Arizona Strip District alone included 3,253,987 acres of land of which 2,416,519 were public domain, 124,040 were railroad lands, 163,963 were state owned, and 418,506 were reservation lands; Forest Service and Park Service lands were specifically excluded from the grazing district by the terms of the Taylor Grazing Act. With limited manpower and funding, the Division was required to fence allotments, control erosion, improve existing water storage facilities and install new ones, and perform a myriad of other tasks necessary for proper development and maintenance of the public range (Lacy 1976:159).

Passage of the Emergency Conservation Works Act of 1933 was a major boost for the Division and was instrumental in helping the division accomplish its stated tasks during the first years of its existence. Civilian Conservation Corps work on the public domain lands of the Arizona Strip commenced around 1935 and continued into the early forties (Wright 1972:3). Two Divisions of Grazing camps (DG 44 and DG 45) were established on the Strip with Post Offices at Fredonia and St. George respectively (John Irish, personal communication 1987). Rusho and Crampton (1981:107) state that a "CCC camp definitely did operate in House Rock Valley for some time, but records of the camp have not been located." Although the specific projects constructed with CCC labor are poorly documented, road work and range improvements appear to have been the primary focus of their activities (Lavender 1984:46). Among other things, CCC labor was apparently used to build stock watering facilities and check dams, fence allotments, and to construct trails and stock driveways (Lacy 1976; Wright 1972:2). There are at least two stock trails reportedly built by CCC labor on the Strip: one at Lee's Ferry and another on the east side of Quail Canyon (Rusho and Crampton 1981:107; Richard Malcolmson, personal communication 1987). In addition, some members of Company 2557, garrisoned at Pipe Springs in 1935-1936, were involved in restoration work on the Monument (Lavender 1984:46).

In 1936, lands were withdrawn from the public domain and incorporated into Boulder Dam National Recreation Area. The southern portion of the Shivwits Plateau was thereby removed from the jurisdiction of the Division of Grazing. In 1944, the Grazing Service (the name was changed in 1939) resumed responsiblity for administrating this area of the NRA.

During the late 1930s, considerable conflict arose between the Grazing Service and other public land management agencies over the proper division of adminstrative responsiblities. It was partly in response to this situation that President Truman developed his Presidential Reorganization Plan No. 2. The plan was sent to Congress in May 1946, and two months later it took effect. Under Section 403 of the plan, the Grazing Service and General Land Office were consolidated as the Bureau of Land Management (Clawson 1971:38). Since then, the Bureau has struggled to implement a broadly based land management program based on the principles of multiple use.

The Forest Service

Until the establishment of the Grand Canyon Forest Reserve in 1893, virtually the entire Arizona Strip was included within the public domain. The only exceptions were the townsites of Fredonia and Littlefield, a few clusters of privately held ranches in the House Rock Valley-Lee's Ferry area and at Pipe Springs, Moccasin, Short Creek, and Beaver Dams, plus a few other widely scattered parcels around Mount Trumbull. Although technically under the jurisdiction of the General Land Office, little effort had been expended on the part of the federal government to administer the area for the public good. Virtually all the usable water sources on the Strip were claimed by local stockmen on an informal basis, and the range was stocked beyond carrying capacity. The establishment of the Grand Canyon Forest Reserve signaled the beginning of the end for uncontrolled exploitation of the Strip's natural resources and carried with it significant implications for the later recreational development of the region.

National attention had been focused on the Grand Canyon region by the writings of John Wesley Powell, the photographs of Beaman and Hillers, and the paintings and illustrations by Moran and Holmes. In 1882, Indiana's Senator Benjamin Harris introduced a bill to Congress that would set aside America's greatest scenic wonder as the nation's second National Park. Although the general concept of a national park had been in existence since the early 1870s, and the first such park, Yellowstone, had been signed into existence by President Ulysses S. Grant in March, 1872, Harrison's initial attempt to create Grand Canyon National Park died in committee. Harrison introduced two more unsuccessful bills in 1883 and 1886. The failure of these bills was largely due to lobbying efforts by local miners, stockmen, and settlers who viewed the proposed change as an unwarranted restriction of their God given rights to mineral exploitation, grazing, and homesteading (Hughes 1978:65).

Although the creation of a National Park required a vote by Congress, the establishment of a Forest Reserve could be authorized by the president without congressional approval. Thus, in 1893, shortly after being elected President of the United States, Harrison took the first pivotal steps to protect the Grand Canyon from further exploitation by issuing a presidential proclamation creating the Grand Canyon Forest Reserve. This move exempted a 300,000 acre area within the Grand Canyon and bordering both rims from all public land laws except those involving mining claims (Shankland 1951:227).

The Grand Canyon Forest Reserve underwent a series of administrative changes during the following two decades. Initially, it was placed under the Division of Forestry within the Department of Agriculture (Russo 1964:31). Four years later, jurisdiction over the nation's forest reserves shifted to the General Land Office in the Department of Interior (Shankland 1951:49). In 1901, the Division of Forestry became the Bureau of Forestry, forerunner of today's Forest Service, and in 1905, responsibility for the forest reserves shifted back to the new bureau in the Department of Agriculture. On July 2, 1908, the Grand Canyon Forest Reserve was officially renamed Kaibab National Forest.

While these bureaucratic changes were taking place during the first decade of the 1900s, a number of administrative sites were established on the forest. Among the earliest such sites was the Ryan administative site (Lang and Stewart 1910). The Jacob Lake Ranger station, built in 1910, is the oldest extant Forest Service facility on the Kaibab today and ranks among the oldest remaining stations in the United States Forest Service Southwest Region (Cleeland 1987b:9). As noted by Cleeland (1987b:9) "these sites, erected in the wilderness, were the first physical manifestation of Forest Service administrative control over our nation's vast timber reserves" (Russo 1964). Small-scale lumbering operations also continued.

An Act of Congress, authorized by Senator Reed Smoot of Utah and dated June 29, 1906, authorized the President of the United States to set aside Grand Canyon Forest Reserve as a preserve for large game animals. With this authority, Theodore Roosevelt issued a Presidential Proclamation on November, 28, 1906, creating the Grand Canyon National Game Preserve. Although not identical, the boundaries of the preserve included virtually all of the lands within the Grand Canyon Forest Reserve.

Within the Preserve, killing of large animals was prohibited. The buffalo introduced to the area by C.F. "Buffalo" Jones earlier that year came under the protection of the preserve, but the Kaibab mule deer herds were the primary beneficiaries. The deer had long been hunted by Paiutes, who traded the meat and hides to the neighboring Navajos. Prior to the arrival of whites, the number of annual kills was severely restricted by bow and arrow technology. After guns became widely available in the late 1800s, hundreds of deer were taken each fall. Although Paiutes did most of the hunting, Anglo settlers also participated. By the turn of the century, only a remnant of the once large deer population remained on the plateau (Rasmussen 1941).

Next to man, the primary threat to the mule deer came from bobcats, mountain lions, and other predators. To remove this threat, the Forest Service hired hunters and trappers on contract. Between 1906 and 1931, 781 lions, 554 bobcats, 30 wolves, and 4,889 coyotes were eliminated from the preserve (Rasmussen 1941:236). "Uncle" Jimmy Owens, hired as game warden for the preserve in 1907, was by far the most zealous and successful of the government hunters; he alone is credited with killing over 500 mountain lions during his tenure on the forest. With the predator threat virtually eliminated, the mule deer herd increased at an unexpectedly rapid rate. The estimated population of the Kaibab deer prior to the establishment of the preserve was 4,000; by 1924, the population was estimated at between 30,000 and 50,000 (Mann 1941:26). Later estimates placed the 1924 population at over 100,000 (Rasmussen 1941).

Damage to the range by deer was first recognized by Forest Service officials in 1918 (Russo 1964:40). In 1920, Ranger Ben Swapp recommended that the government initiate a hunting program to reduce the population (Swapp 1966:1). Swapp's controversial recommendations, published as part of the Forest Supervisor's annual report, led to a series of investigations by government biologists and and representatives from various wildlife conservation organizations. Conflicting opinions and recommendations were published in the ensuing reports (Cutting et al. 1924; Evarts 1924; Goldman et al. 1922; Goldman and Locke 1923; Locke 1920; Shiras 1924).

In the winter of 1924-1925, the problem reached crisis proportions. The combination of poor feed and severe winter weather resulted in a massive die-off of the mule deer herd. It is estimated that over 60 percent of the deer succumbed that winter (Rasmussen 1941:237). With this irrefutable evidence of overpopulation, the Forest Service was finally forced to take action. Beginning in 1925, several measures were implemented to reduce the deer population by 50 percent. The first and undisputably least successful approach was Charles McCormick's ill-fated cross-canyon deer drive. In December 1924, McCormick, a resident of Flagstaff, lead an attempt to drive 5,000 deer down the Nankoweap Trail across the Colorado River and up the Tanner Trail to the South Rim of the Grand Canyon. Around 125 men reportedly took part in this event, including 70 Navajos (Mann 1941:20). The deer refused to cooperate. It is reported that by the time the drive line reached Saddle Canyon, not a single deer was in front of the line but thousands were behind it (Mann 1941:20). Forest Supervisor Rutledge, a participant in this fruitless effort, told Ben Swapp it was "the most interesting failure he had ever witnessed" (Swapp 1966:7).

Another deer reduction measure involved capturing live fawns, rearing them by hand on cows milk, and then selling them to individuals (Report of Game Management Committee 1930; Russo 1964). The "Adopt a Fawn" program led to the establishment of several "fawn farms" on the plateau. Initially, these "farms," which consisted of little more than wood and wire corrals and temporary storage buildings, were located in the vicinity of existing dairy operations at Mile and a Half Lake and three other locations on the plateau (Russo 1964:53). After 1927, these government operated deer farms were abandoned, and instead, contracts for the capture and rearing of fawns were issued to residents of Fredonia and Kanab. The program was largely unsuccessful due to the high mortality rate of the captive fawns. The practice was finally abandoned in 1930 (Russo 1964:51-54; cf. Mann 1941:20).

During the same period (1925-1930), live-trapping of adult deer was also practiced (Russo 1964). Ben Swapp constructed a 1.5 acre trap corral near Big Springs Ranger Station as part of this program (Swapp 1966:6), and similar traps were constructed on other parts of the plateau. Like the fawn-rearing program, the live-trapping effort was largely a failure due to the high mortality rate of the captured deer.

Not surprisingly, hunting was found to be the most succesful population reduction method. Forest Service officials realized this from the outset, and in 1924, they attempted to implement the first controlled hunt in the preserve. In mid-November, Coconino Sheriff William Campbell arrested three hunters as they were leaving the preserve with their kills. This act marked the opening round of a four-year court battle between the State of Arizona and the U.S. Forest Service. The case ultimately went to the U.S. Supreme Court and became a landmark study in the legal definition of federal property rights within the borders of established states (Foster 1970:255). On November 19, 1928, the Court issued a decision in favor of the Federal Government, and deer hunting was promptedly reinstituted (Foster 1970:262). In December, 1928, government employees killed 1,124 deer over a ten day period. The following year, an agreement was reached between U.S. Forest Service and State Game Department officials, which allowed for the cooperative involvement of State Game representatives in future hunts (for additional information on hunting, see recreation discussion below).

Permanent hunting camps were established on the forest beginning in 1924 (Russo 1964:59). All hunters were required to stay at a designated camps on the forest. Hunters checked in and out of the camps each day. The purpose of maintaining these camps was to regulate all hunting activities on the forest (Mann 1941:21). The camps were equipped with cabins or wall tents and mess halls. The earliest such camp is believed to have been at Slide Reservoir (Russo 1964:59); another early camp was located in Moquitch Canyon (Russo 1964:58). These camps were apparently discontinued in the 1940s.

Wildlife management was only one concern of the early Kaibab forest rangers. Timber management and fire prevention were other central issues. In the spring of 1910, the Forest Service conducted its first inventory of the timber resources on the Kaibab Plateau (Lang and Stewart 1910). This survey was prompted in part by Utah Southern Company's expressed interest in constructing a railroad line to the North Rim of the Grand Canyon, which would make large scale timbering commercially feasible. At that time, the main limitiation to economic development of the North Rim, and indeed the entire Arizona Strip, centered on the lack of adequate transportation facilities (Lang and Stewart 1910:5; see also discussion on recreation and tourism below). The timber survey determined that there was approximately 1,362,130 million board feet of marketable lumber on the forest. Ultimately, the plan for the railroad fell through. It was not until the post-World War II economic boom that large-scale lumbering took place on the Kaibab Plateau (Fawcett 1966; see discussion on lumbering above).

In keeping with the conservation policies of Chief Forester Gifford Pinchot, an early management emphasis in the Forest Reserve was fire prevention. Beginning some time in the teens or early twenties, fire lookouts were constructed at strategic locations throughout the forest. As is the case elsewhere in the Southwest region, the earliest fire lookouts consisted of open wooden platforms placed high up in living trees (Steere and Miller n.d.). Structures of this type were built in the Tipover, West Lake, Telephone Hill, Dry Park, and Francis Lake areas (Steere and Miller n.d.:86), and probably at several other locations as well. In the 1930s, the Dry Lake lookout tree was superceded by a wooden tower structure (Steere and Miller n.d.:83). Presumably similar structures were erected at other locations during the late twenties or early thirties, but no documentation of them is curently available. These early fire lookouts usually had a cabin and storage facilities located nearby. Beginning in the mid-thirties, steel towers designed by the Aerometer Company of Kansas began to replace the wooden towers (Steere and Miller n.d.). In 1934, for example, two 100-ft-high Aerometer MC 31 steel towers with 7 by 7 ft steel cabs were erected at Jacobs Lake and Big Springs (Steere and Miller n.d.:82).

On other forests in the Southwest, construction of fire lookouts during the mid to late thirties was often performed by crews employed by the Civilian Conservation Corps (CCC). The Kaibab Forest used Kanab residents for this task, since CCC labor was unavailable (Steere and Miller n.d.:82. There is in fact no readily available record of any CCC camp on the North Kaibab, although CCC projects were conducted on adjacent Park Service and public domain lands. The only documented CCC project that had a direct bearing on the Kaibab Forest was the construction of a portion of the North Rim boundary fence in 1938 (Hughes 1978:90).

Regulation of grazing on the forest prior to 1905 was minimal (Russo 1964:35). Throughout the period prior to 1905, land management policy seems to have been dominated by the "live and let live" principle (Russo 1964:35). Even so significant reductions in the numbers of livestock grazing on the forest are postulated during the twenty-year period between 1885 and 1905. Prior to the establishment of the Forest Reserve, approximately 20,000 cattle and 200,000 sheep were estimated to have grazed on the plateau. By 1906, the numbers had been reduced to 9,000 cattle and 20,000 sheep. It is not clear if these reductions occurred voluntarily or were forced upon the ranchers by the depleted condition of the range. Even with these reductions, however, the forest lands were unable to support the existing livestock herds and conflicts between the Bar Z outfit, which owned approximately half of the cattle on the range, and smaller permit holders inevitably developed.

Late in the first decade of the twentieth century, the Forest Service was finally forced to deal with the grazing issue. In order to separate the Bar Z cattle, which grazed on the east side of the plateau, from those owned by Kanab cattlemen on the western slopes of the Kaibab, a drift fence line was surveyed in 1909 and the fence constructed between 1909 and 1911 (see discussion on ranching above). The next significant range-control fence erected by the Forest Service was the old east side drift fence, built about 1915 (Prevy 1967:2).

A significant event in the history of the Strip occurred in 1919, when the Grand Canyon National Park was established. Some 340,000 acres north of the Colorado River were removed from United States Forest Service jurisdiction as a result of this action. Up until this time, the Grand Canyon had been the primary destination of recreational visitors on the Forest. Beginning in 1920s, however, the Forest Service began to take a more active role in promoting the recreational qualities of the forests. This new emphasis was promoted by the third Chief of the Forest Service, William B. Greeley (Hinton 1987:69). Under Greeley's administration, use of the forest for recreational camping and sport hunting became an important aspect of the multiple use land management policy.

Recreation and Tourism

As early as the 1880 local entrepreneurs were seeking ways to profit from the natural and scenic resources of the North Rim country. While representing the LDS church in England, John W. Young, son of Brigham Young, devised a scheme to develop the Kaibab area as a hunting resort for English aristocracy. Although English agents were not thrilled with the idea, Young enticed them to examine the region first hand by embellishing his presentation with designs for hunting lodges and hotels. He also arranged for "Buffalo Bill" Cody, who was performing in England at the time, to replenish his livestock from Young's own Arizona Strip herds and also persuaded Cody to act as a tourleader for the group of English noblemen. With arrangements complete, the trip was made in the summer of 1892 (Crampton 1985:201-202). The group was met in Flagstaff by Dan Seegmiller, Young's "foreman," who guided them to House Rock Valley and the Kaibab Plateau via Lee's Ferry. The party consisted of Janius Wells, "Buffalo Bill" Cody and his crack rifle shooter, John Baker, and three Englishmen, Major McKinnon, Lord Ingram, and Lord Milmey. They were entertained by local cattlemen E.D. Wooley, Ed Lamb, Jr., Walter Hamblin, Alex Cram, Ebenezer Brown and Al Huntington (Woodbury 1944). Unfortunately for Young, whose financial affairs were in a shambles, the natural beauty of the Strip and the excellent hunting could not overcome the Englishmen's impression that the area was simply too remote and too far removed from the centers of transportation to be a profitable venture.

The early promoters of tourism made a point of down playing the difficulties of access to the North Rim Country. In 1896, Dan Seegmiller drove a white-topped buggy from Kanab to Milford, picked up a group of tourists from New York, and brought them to the north rim of the Grand Canyon. E.D.

Wooley, president of the Kanab Stake and a subsequent owner of the VT Ranch, also took tourists back and forth to the North Rim over the Kaibab. Wooley became the most prominent early promoter of tourism on the Strip, and subsequently organized the Grand Canyon Transportation Company in an attempt to construct a trail across the Grand Canyon. With the aid of James Emett, and Wooley's son in law, David Rust, the company improved the old Indian route down Bright Angel Canyon to make it suitable for pack horses and installed a cable across the Colorado River. The work was started in 1901 and took seven years to complete. Originally, the company intended to charge a toll for use of the trail, but Federal regulations prevented implementation of this plan. The company was restricted to earning revenues for transportation and guide services, and from the meager accommodations provided at a tourist camp near the mouth of Bright Angel Canyon (Hughes 1978:76). Wooley was also involved in bringing the first automobiles to the North Rim in June 1909 (Woodbury 1944:193).

Despite the promotional efforts of Wooley and others, the difficulties of access and lack of tourist accommodations dissuaded all but a few hardy travelers from undertaking the long and often harzardous journey to the North Rim country. Those who did make the journey often received considerable publicity for their efforts. Sharlot Hall published a popular series of articles on her 1911 trip in the monthly magazine Arizona (Crampton 1975:7), former President Theodore Roosevelt described his 1913 lion hunting expedition in The Outlook (October 4, 1913), and J. Cecil Altus, then director of the U.S. Weather Service, reported the highlights of his cross canyon expedition in the Salt Lake Tribune (August 13, 1913, and January 4, 1914). The latter accounts aroused so much enthusiasm that the Tribune decided to sponsor a "pathfinder's tour" to log the road to Grand Canyon (Woodbury 1944:195).

Gradually, the combined effects of this publicity began to produce results. During the summer of 1913, Wooley and others encouraged the U.S. Forest Service to construct a road south from Salina to the state line on the route to the North Rim, and in the fall of that year, the Forest Service began construction of a "boulevard" from Jacob's Lake to the North Rim (Woodbury 1944:195). The following year, the Grand Canyon Highway Association was formed. This organization was made up of representatives of the Washington, Kane, Iron, and Beaver counties in Utah and Coconino County in Arizona. Their goal was to upgrade the existing roads through lobbying efforts in local and national political channels (Woodbury 1944:196). In the meantime the Salt Lake Tribune, in cooperation with the Union Pacific Railroad, sponsored another tour through the Strip to the North Rim. As a consequence, the Arrowhead Trail Association was formed to develop roads and tourism in southern Utah and northern Arizona (Woodbury 1944:198). Within the next few years, improvements in transportation brought tourists to the Arizona Strip in increasing numbers.

In June, 1923, the Union Pacific Railroad opened a branch line from Lund, Utah, to Cedar City (Hinton 1987:76). Shortly thereafter, the Union Pacific and the Utah and Grand Canyon Transportation Companies began actively promoting tours to the North Rim, with stops at Zion National Park and Bryce Canyon. The tour featured an overnight stop at the the V.T. Park Tourist Camp, now known as Kaibab Lodge. Total driving time from Fredonia to the North Rim was listed as 4.5 hours (Anonymous 1926). Broken crockery with the Union Pacific trademark found occasionally at scattered locations along the Jacob Lake North Rim road probably date between the late 1920s and 1950s when the Utah Parks Company, a subsidiary of Union Pacific, served as the North Rim concessioner (Hughes 1978:97; Fairley et al. 1984:17).

The opening of Navajo Bridge on June 15, 1929, probably did more for the development of tourism on the Arizona than all other efforts combined. The dedication of this steel arch span was touted by the news media as "The Biggest Event in Southwest History" (Coconino Sun, June 21, 1929). During construction of the bridge and shortly thereafter, several new tourist facilities sprang up along the highway leading toward Jacob Lake and the North Rim. Marble Canyon Lodge, Vermilion Cliffs Lodge, and Cliff Dweller's Lodge all were constructed during the 1930s. Most of the original buildings have since been replaced, but some of the original structures are still standing (Wright n.d.). For example, the little rock structure nestled under a boulder next to the highway at Cliff Dweller's Lodge was reportedly built by individuals involved with the construction of Navajo Bridge (Marietta A. Davenport, personal communication 1987).

After World War II, Americans found more leisure time and vacations became an annual event for many. Improvements in transportion technology and a booming post war economy encouraged long distance travel. Consequently, greater numbers of Americans and foreigners have found their way to this remote corner of Arizona, and residents of the Strip have come to rely on tourism for their economic well being (Tavernetti 1971).

CONCLUSION

Historic occupation of the Arizona Strip can be logically divided into the following two broad categories: Spanish and Mexican exploration (1776-1848) and Mormon and Gentile settlement (1846 to the present). Within the latter category, Mormon and Gentile settlement patterns can be examined from a cultural historical perspective as well as political and economic development (agriculture, mining, timber, and tourism). These general themes, which represent broad historical processes, provide an outline for examining the historic occupation of the Arizona Strip.

The historic resources of the Arizona Strip symbolize the human motivations for life on the Strip: for the Spanish and Mexican explorers, the Arizona Strip was an obstacle to overcome; for the Mormons it represented a safe haven on which a future could be built; for American miners and timber managers it represented a source of potential wealth. Sites created as a result of historical activities provide tangible evidence of broad historical processes. It is hoped that this historical overview will foster a better understanding of historical sites and the context in which they were created on the Arizona Strip.

CHAPTER 6

DATA GAPS AND RESEARCH ISSUES IN ARIZONA STRIP PREHISTORY

Helen C. Fairley and Phil R. Geib

As Chapter 4 demonstrates, the broad outlines of Arizona Strip prehistory are only begining to emerge. There are still numerous temporal and geographical gaps in the archaeological record that need to be addressed and a myriad of research questions that remain to be answered. In the following pages, the major data gaps are delineated, and several major research issues are discussed.

This chapter deals only with prehistory. This orientation reflects the expertise of the authors, and is not a statement about the relative importance of history and prehistory. The general research issues are designed to provide a comprehensive structure of inquiry to focus and organize future investigations on the Arizona Strip. Under each major research domain, a series of specific research questions are raised. These questions do not encompass the full range of research issues that need to be examined; rather, they are intended to serve as examples of the types of questions that could be investigated by future work in the area. The types of data required to address these various issues are briefly summarized, and suggestions for collecting and organizing these data in a systematic fashion are offered.

GEOGRAPHICAL DATA GAPS

Knowledge of the cultural resources of the Arizona Strip seems to be inversely related to the distance from northeastern Arizona and the Utah State line. As one moves southwestward from the Paria River towards the Sanup Plateau, the database becomes increasingly sketchier and more difficult to decipher. This pattern is undoubtedly in part a function of the remoteness and undeveloped condition of the Shivwits Plateau region relative to some other parts of the Strip. A general apathy on the part of the archaeological community towards the "unspectacular," nonstructural sites that predominate in this area may also be partly responsible.

Although the cultural resources in the eastern part of the Strip are relatively well known in comparison to those west of the Hurricane Cliffs, there are still large spatial gaps in the coverage of the eastern and central areas. The eastern two thirds of the Paria Plateau have never been systematically examined by archaeologists, and only one small site has been excavated on the plateau by archaeologists. In recent years, BLM archaeologists have resurveyed portions of Museum of Northern Arizona's Paria Plateau survey area and recorded a number of lithic scatters that were overlooked during the 1967-1968 inventory. Systematic inventory of previously unsurveyed portions of the plateau, in conjunction with excavations, could significantly expand our current understanding of the pre-Anasazi occupation on the Paria Plateau, as well as contribute to a more detailed interpretation of the Formative period occupation.

The only published knowledge we have concerning the area south of House Rock Valley comes from Judd's brief reconnaissance of the area in 1919. Euler's 1966 helicopter reconnaissance of the Buck Farms Saddle Mountain area and USFS sponsored cultural resource surveys of road, fence, and fireline corridors in House Rock Valley and along the eastern flank of the Kaibab Plateau indicate that these areas have a strong potential for contributing important information about the hypothesized Kayenta Anasazi occupation of the eastern Arizona Strip.

There has never been an intensive survey of Snake Gulch, despite frequent references in the popular literature to numerous rock art panels in this canyon. Schaafsma (1988) suggests that a wide variety of rock art styles are represented in this area, including some that resemble Basketmaker and Fremont styles. Scientific documentation of these remains would significantly expand current understanding about the geographic distribution and possible temporal cultural affiliations of specific rock art styles on the Arizona Strip.

Our knowledge of the archaeological resources on the central Kanab Plateau is still rudimentary, as demonstrated by the fact that until 1985 no structural sites were on record in the BLM files for this area; yet within the last two years, BLM archaeologists have documented several dozen (Jennifer Jack and Greg Woodall, personal communication 1986). The National Park Service's .5 percent sample survey of lands adjacent to Grand Canyon National Park (Teague and McClellan 1978) perpetuated a misconception that there were few significant cultural resources in the general area, despite the fact that Thompson (1971b) had previously documented several hundred sites within the boundaries of the Grand Canyon National Monument, many of which were in sheltered locations or had associated structural remains. Recent surveys and excavations conducted in conjunction with uranium mining in the area (e.g., Bond 1982; Brown 1982a, 1982b; Westfall 1987a, 1987b) have considerably improved our understanding of Kanab Plateau prehistory, but at the same time these studies reveal how much is still unknown about the area. Since the early 1980s, several new roads have been constructed on the plateau in conjunction with ongoing mining developments, and as a result, the sites in this area have become increasingly vulnerable to vandalism. At a minimum, a region-wide, statistically reliable sample inventory of the cultural resources in this area is presently needed to provide a baseline for evaluating continuing impacts to the sites in this area, as well as enhancing our current understanding of regional prehistory.

Although the eastern half of the Strip has numerous areas in need of additional investigation, it is relatively well studied in comparison to the western half. Aside from excavations at Antelope Cave, a handful of power and seismic line surveys, and some drill pad inventories, virtually no archaeological work has been conducted on the northern Uinkaret Plateau. There is a tendency to view the northern grassland areas of the Uinkaret as an uninhabited void used only sporadically for hunting, collecting, and quarrying activities (e.g., Moffitt et al. 1978). Although this may be true for certain time periods, it is not necessarily applicable to the entire span of prehistory. Given the considerable evidence for significant vertical shifts of major vegetation zones within the inner Grand Canyon during the first half of the Holocene (see Chapter 2), it seems likely that the extensive grassland zone in the central portion of the Arizona Strip (now largely reduced to sagebrush as a result of historic overgrazing) formerly exhibited a greater abundance and diversity of floral resources, particularly during the late Paleoindian and early Archaic periods. Furthermore, archaeological evidence from other areas of the Southwest indicate that grass seeds provided an important subsistence resource for the Anasazi (Winter 1974), as well as for Archaic and Southern Paiute hunters and gatherers. Thus, archaeological sites in this area have the potential to contribute important information concerning this little understood aspect of prehistoric behavior. In any case, there is a serious need to document the types and distributions of sites on the northern Uinkaret Plateau in order to further our understanding of prehistoric settlement patterns on a regional scale.

Surveys conducted by BLM personnel in the western portion of the Strip are, for the most part, inadequate for archaeological research or cultural resource management purposes, due to inconsistent survey coverage and site recording procedures (see Chapters 8 and 9, this volume). At this point, it is impossible to determine which areas on the Shivwits Plateau are most likely to contain the densest site concentrations or even if such concentrations exist. We know from the brief surveys by Baldwin (1978), Evans et al. (1969), and Shutler and Griffith (Shutler 1961), that Puebloan structural sites do occur in the area, but where and in what numbers is anybody's guess. Based on MNA's surveys in the Beaver Dam Mountains and around Mount Trumbull, the University of Nevada's surveys around the Virgin Mountains in southeastern Nevada (Ellis et al. 1982; Rafferty and Blair 1984), plus USFS records of sites along the flanks of the Kaibab Plateau, one would expect a high site density to be present in the pinyon- juniper woodlands surrounding the flanks of the Virgin Mountains, around Mount Dellenbaugh, and along the southern and western rims of the Shivwits Plateau. No serious attempts have been made, however, to determine whether this is in fact the case.

The canyons draining the western flanks of the Shivwits are another significant archaeological void. Lipe and Thompson (1979) believe that the alluviated portions of these canyons probably contain numerous sites, but there has been no effort as yet to verify this hypothesis. In fact, the only area in the western half of the Strip country that can be considered relatively well known is the main corridor of the lower Virgin River between St. George and the Arizona-Nevada line. Yet even in this area, only selected portions have received intensive coverage.

On a more general level, there is a critical need at this time for additional excavations of stratified shelters in the upland areas of the Strip to help tie cultural sequences exposed at lowland sites such as Willow Beach and the Wild Goose site to those on the adjoining plateau. In addition to valuable chronological information, sheltered middens are likely to produce significant data pertaining to changing patterns of resource utilization, perishable technology, and diet; yet sheltered sites are disappearing from the cultural resource base at an alarming rate due to commercial and private pothunting activities. The excavation of the Wild Goose site has been the only excavation of a rockshelter conducted on the Arizona Strip in advance of extensive disturbance. Regrettably, however, a comprehensive report on the investigations was never produced.

At three sheltered sites recently investigated by National Park Service archaeologists (Jones 1986b, 1986c), disturbance from visitation, relic collecting, and natural erosion prompted archaeological intervention. Only the minimum amount of excavation necessary to reveal an undisturbed profile of the deposits was conducted, yet the wealth of data that was recovered from this limited amount of excavation was truly phenomenal. This small-scale testing project illustrates the potential contribution of small-scale testing projects involving stratified sheltered deposits and their critical importance for furthering knowledge of Arizona Strip prehistory.

RESEARCH ISSUES

The research issues identified below are by no means exhaustive. They are focused around three topics: cultural ecology, regional interaction, and cultural change. The major research domains include chronology, paleoenvironment, subsistence, technology, settlement organization, cultural boundaries, and ethnic groupings. The discussion of each research issue begins with a brief introduction, followed by a list of temporally specific questions. An overview of the kinds of data needed to address these questions and the methods required to obtain the data completes each section.

Chronology

Reconstruction of culture history depends upon temporal control. Without a means for establishing chronological order, archaeologists are unable to relate the material evidence of past cultures with cultural developments through time. Issues of growing concern in archaeology, such as the processual dynamics of cultural change and the specific factors responsible for such change, cannot be examined in a chronological vacuum. Clearly, establishment of a regional temporal framework is prerequisite to understanding prehistoric human behavior.

Questions

There are two basic chronology questions that need to be addressed: What were the periods of human occupation on the Arizona Strip? And, when did occupational hiatuses occur? To answer these fundamental questions, we need to be able to pinpoint the time of occupation of individual sites. Thus, the essential question to be addressed at any given site is, during what time was each site component utilized? On a more regional level, we need to determine whether the dates extrapolated from surrounding areas and assigned to various temporal periods and specific cultural developments on the Arizona Strip are appropriate for this area. For example, the beginning date for the Paleoindian period is derived from data collected hundreds of miles from the Strip. Can this date be supported by chronometric information from the Arizona Strip? Questions specific to the chronology of the Arizona Strip include the following:

1) Is 9500 B.C. an accurate estimation for the initial use of this area or is it too early or too late?

2) Are the dates for the various Paleoindian complexes identified within the region similar to those already documented in other portions of the Southwest?

3) Are the dates assigned to the various Archaic projectile point styles on the basis of Holmer's (1978, 1986) analyses applicable to this area?

4) Does the recently revised dating of Basketmaker II remains from the Kayenta region to ca. 500 B.C. (Smiley et al. 1986) apply to the Arizona Strip?

5) When did specific cultigens, such as beans and cotton, make their initial appearance in the region?

6) When did such significant technological developments as ceramics, the bow and arrow, and water control systems first come into use?

7) Is there continued occupation of the Arizona Strip during the thirteenth century, as suggested by several recent radiocarbon determinations (e.g., Jones 1986b; Thompson and Thompson 1974; Westfall 1987b), and if so, to what extent does the dating of the indigenous Anasazi ceramic chronology need revision?

Data Needs

Diagnostic artifacts that have been directly dated or recovered from dated stratigraphic contexts provide the most efficient means for assigning sites to particular temporal periods, especially in the context of archaeological survey. Ideally, the dates on diagnostic artifacts should be obtained from a series of carefully controlled excavations within the region, rather than through extrapolation from surrounding areas. Unfortunately, this ideal situation does not exist on the Arizona Strip. Reconstruction of Arizona Strip culture history is hampered by a shortage of excavation data in general, by the paucity of excavation at stratified sheltered sites in particular, and by the failure of past researchers to emphasize the collection of radiocarbon and dendrochronological samples at the handful of sites that have been excavated. Since the early 1970s, this situation has improved dramatically. Nevertheless, the number of absolute dates derived by dendrochronology, radiocarbon, or any other of the newer dating techniques such as obsidian hydration, thermoluminescence, or archaeomagnetism is still very limited. The applicability of these various techniques to cultural resources on the Arizona Strip and the problems associated with each method are briefly reviewed below.

Chronometric Dating Methods

Dendrochronology. Dendrochronology is the most accurate method for dating sites less than 2,000 years old, but attempts at using this approach have met with a notable lack of success on the Strip. The few tree ring samples submitted for analysis have all proved undatable, either because of species unsuitability (e.g., juniper) or because the timbers originated from well watered localities, making the tree rings complacent (e.g., ponderosa from the Kaibab Plateau) (Robert C. Euler, personal communication 1986). Even with suitable samples, dendrochronologists must still grapple with the problem of fitting Arizona Strip tree ring data to existing master chronologies from surrounding regions (see Chapter 2). Since local climate fluctuations may produce tree ring growth patterns that differ from those in surrounding areas, to ensure reliable results it may be necessary to develop a regionally specific master chronology. Development of a local chronology, however, depends on the recovery of a large number of noncomplacent, temporally overlapping samples that can only be obtained through a concerted dendrochronological program.

Despite the limited success of this technique on the Arizona Strip, the potential return on the effort expended searching for and securing suitable specimens is very high. Not only is the precision offered by tree ring dating unmatched by any other currently available technique, but the analysis can also provide valuable paleoclimatic information. Douglas fir, ponderosa, and pinyon usually provide the best results, but juniper can also be used in some cases. The recovery of intact dendrochronological samples should be given a high priority in all future excavation projects on the Arizona Strip.

Radiocarbon. Radiocarbon dating has been slighted by many previous investigators, in part because of the cost factor, but primarily because the majority of archaeological investigations have concentrated on Puebloan sites that contained ceramics. Ceramic cross-dating offers a much cheaper and theoretically more precise alternative to radiocarbon dating. Because so few radiometric dates were collected in the past, the temporal depth of archaeological remains on the Strip has only recently been acknowledged. Radiocarbon dating of split twig figurines, for example, provided the first evidence of a late Archaic presence in the Grand Canyon region (Schwartz et al. 1958; Euler and Olson 1965); a contemporaneous occupation on the plateau uplands, although long suspected from the presence of distinctive projectile point types (e.g., Mueller et al. 1968; Teague and McClellan 1978; Moffitt et al. 1978; Fairley et al. 1984), was not actually confirmed until 1984-1985 with the testing at AZ:A:16:1 (ASM) (Jones 1986b) and salvage excavation at Rock Canyon Shelter (Wilde 1986).

Because radiocarbon dating is usually confined to projects involving subsurface investigations and relatively few excavations have been conducted on the Strip, the current suite of radiocarbon dates from this area remains quite limited. In addition to the examples cited above, other projects that have employed radiocarbon dating include the Navajo-McCullough transmission line excavations (Moffitt et al. 1978), Southern Utah State College's excavations in the Tuweep Valley area (Thompson and Thompson 1974), the Unkar Delta excavations by the School of American Research (Schwartz et al. 1980), Brigham Young University's excavation at Antelope Cave (Joel Janetski, personal communication 1987), and Abajo Archaeology's excavations at Kanab North (Brown 1982a) and the Pinenut site (Westfall 1987b).

Given the pressing need for additional chronological data, the possibility of extracting radiocarbon samples from survey situations needs to be considered. A carefully controlled approach involving the selective sampling of hearths provides one means for obtaining valuable chronological data in a cost effective manner.

The selection of hearths for sampling should be made with several temporal, functional, and seasonal criteria in mind. If projectile points are in association, sampling could help to broaden and tighten the existing point chronology for the area. If other potentially diagnostic tool forms are present, or when the debitage sample is sufficiently large so that technological distinctions can be derived, hearth sampling may allow us to refine the temporal associations of these remains. Sampling should also be undertaken when hearths with unusual and potentially diagnostic shapes occur.

Only hearths that are readily visible on the surface, with well defined perimeters, should be considered for sampling. Depending on their size, only a quarter or less of the selected hearths needs to be excavated. Not only can radiocarbon samples for dating purposes be recovered, but flotation and pollen samples can (and should) be collected as well. A cross-sectional profile of the hearth fill should be drawn, showing the stratigraphic locations of the various samples, and photographs should be taken before, during, and after the excavation. Upon completion of the sampling, it is recommended that an aluminum tag inscribed with the date and the name and instituional affiliation of the excavator be placed within the excavated portion prior to backfilling with clean, sterile sand.

This approach has recently been implemented in the Glen Canyon National Recreation Area on an experimental basis with a high degree of success (Geib et al. 1987). The field time required to complete this procedure ranges from one to three hours, depending on the size and complexity of the feature. The chronological and subsistence data that can be extracted by this method are well worth the investment. Whether this approach is employed on a routine basis during survey, or only in those instances where a site is threatened, it is important to recognize the high data potential of these features. Given the limited amount of absolute chronological data available from the Strip, sites with hearths should be evaluated as significant according to 36 CFR 64, criterion d.

Relative Dating Methods

Despite the desirability of obtaining chronometric dates from primary contexts, they are often not available or can be so expensive that only select samples can be processed. Consequently, most chronological determinations are likely to be based on cross-dated artifacts. Given the frequency of open sites, these artifacts will usually be nonperishable items recovered from surface contexts. The primary artifacts in this category are ceramics and projectile points.

Ceramics. On the Arizona Strip, the placement of sites within a temporal framework has relied primarily on ceramic cross-dating. The temporal spans assigned to indigenous Virgin branch ceramics are largely based on the dating of "analogous" types recovered from tree-ring dated contexts in the neighboring Kayenta Anasazi region (Colton 1952). Although cross-dating has a venerable legacy in archaeology and is generally considered to be a sound approach when applied within a geographically limited area, the reliability of the technique decreases inversely with the distance separating the directly dated and the cross-dated artifacts. As distance increases, questions concerning stylistic lag and the role of local tradition enter into the equation.

In the case of the Arizona Strip, this problem is compounded by the fact that local ceramic types are not strictly analogous to the comparatively well-dated Kayenta Anasazi types (see, for example, Walling et al. 1986:352). In fact, it has become increasingly apparent in recent years that design styles and vessel forms of the Virgin and Kayenta series of Tusayan White and Gray wares are only partially comparable and that most of the overlap that does occur is restricted to the latest types. Furthermore, similar forms and modes of decoration do not co-occur at the same time or in the same contexts in both areas. For example, large ollas with long, tapering narrow necks and bowls with bilaterally symmetrical design layouts that were common in both the Kayenta and Virgin Anasazi areas during Basketmaker III times persisted in the Virgin area well into Pueblo II times, whereas in the Kayenta region they became rare after ca. A.D. 800. Corrugated jars first made their appearance in the Kayenta area around A.D. 1000, and by A.D. 1050 had virtually replaced all other utility types (Ambler 1985). In contrast, the most current evidence from southern Utah suggests that corrugation did not appear in the Virgin area until ca. A.D. 1050 (Dalley and McFadden 1985; Walling et al. 1986) and some investigators (e.g., Nickens and Kvamme 1981) argue for an even later introduction date, ca. A.D. 1100. Furthermore, plain gray utility wares persisted alongside the corrugated varieties in the Virgin area throughout Pueblo II, while plain gray ceramics were virtually nonexistent in the Kayenta region between A.D. 1050 and 1200 (Ambler 1985).

Another example illustrating the lack of comparability between Virgin and Kayenta series is the type Dogoszhi Black-on-white, which is dated in the Kayenta area from about A.D. 1070 to 1200. Virgin sherds exhibiting hatched designs are assumed to fall within the same time slot assigned to Dogoszhi Black-on-white. Yet, in the Virgin area Dogoszhi-like hatchures occur most commonly on bowls, whereas in the Kayenta region the type Dogoszhi Black-on-white is essentially restricted to large ollas. The lack of comparability in terms of vessel form raises serious questions about the cross-dates assigned to the Virgin analog of Dogoszhi Black-on-white.

Aside from the problems inherent in the use of ceramic analogs for cross-dating, the dating of the Kayenta types is by no means definitive. The dates assigned by Colton to the Virgin branch analogs were based on the best information then available from the Kayenta Anasazi region. Since the 1950s, a considerable number of additional dendrochronological dates have accumulated, permitting revisions of Colton's original dates for the Kayenta branch ceramics. Breternitz (1966) undertook the first revision, but his approach had the effect of lengthening allotted timespans, rather than refining them. Recently, independent studies by Dean (1982) and Ambler (1985) have suggested more restricted timespans for certain key Kayenta types. Potentially these revisions could have a profound influence on interpretations of Arizona Strip prehistory. For example, it is commonly stated in the published literature that the Anasazi abandoned the area north and west of the Colorado River by A.D. 1150, yet a considerable number of sites on the Paria Plateau, House Rock Valley and the eastern Grand Canyon exhibit the type Flagstaff Black-on-white. Breternitz placed the beginning date for this type at A.D. 1100, but studies by Dean (1982) and Ambler (1985) place the initial date of manufacture after A.D. 1150 and possibly as late as A.D. 1170. On this basis, we must assume that abandonment of the Strip was not complete until at least the beginning of thirteenth century (Jones 1986b).

In a study of ceramic type frequencies from several, securely dated, single component Kayenta Anasazi sites, Ambler (1985) demonstrated that the relative abundance of various Kayenta types at any point in time can be delineated within a relatively short temporal span (Figures 48 and 49). When moderately large samples of 100 sherds or more are available, the collection can be seriated within cumulative frequency polygons of types by ware. Ambler's study indicates that it is the proportions of types within wares that are important for dating purposes, not merely the presence or absence of types, nor their proportions within the assemblage as a whole. Since the relative percentages of types change rapidly, the occupational median of sites with large enough samples can be estimated to within a few decades.

Having said all this, the fact remains that ceramic cross- dating using Virgin Anasazi analogs and Kayenta Anasazi ceramic dates is still the most viable alternative for assessing the temporal placement of Formative period sites on the Arizona Strip. Given this less than ideal situation, it is imperative that researchers be consistent in their use of ceramic type names. Thompson's suggested modifications of the Colton typology (Walling et al. 1986:352 360) and his suggested temporal spans for each type (Figure 50) offer convenient reference points. Consistent usage of type names will facilitate any adjustments to the temporal placement of sites that may become necessary as more chronological information becomes available from the Arizona Strip.

Finally, it is worth pointing out that even when there is an inadequate number of decorated types for assigning a site to a specific Pecos period, it may still be possible to place the site in a broader temporal category on the basis of the graywares. Studies by Nickens and Kvamme (1981), Jenkins (1981), and Lyneis (1986b) point out the importance of corrugated sherds as temporal markers. Current information suggests that corrugated sherds were not produced in the Virgin area much before A.D. 1050. Thus, based on the presence or absence of corrugated ceramics, it may be possible to assign sites to Basketmaker III-early PII (early Formative) or mid-Pueblo II-Pueblo III (late Formative) divisions. At single component sites with corrugated sherds, the relative percentages of corrugated to noncorrugated graywares may be useful for refining the site's temporal position within the late Formative division (Lyneis 1986b).

Projectile Points Projectile points are the most temporally sensitive lithic artifacts, and hence the most useful for dating purposes. They are particularly useful for dating Paleoindian, Archaic, and Neo-Archaic sites, although they can be of value in dating aceramic Formative sites as well. An essential factor affecting the usefulness of projectile points for dating is the consistency of typological identification. Consistent use of named types fosters communication between researchers and facilitates comparisons of regional prehistories throughout northern Arizona, Utah, and the western Great Basin. Holmer's (1978) typology, with its detailed, mathematically defined descriptions of morphological types, is probably best suited to this task.

The approach followed by Holmer involves digitized measurements to put previous subjective classifications of Great Basin point types on an objective basis. The procedure involves 1) digitizing the plan morphology of points used for the original type definitions, 2) isolating statistically significant differences among those types using discriminant function analysis, and 3) categorizing other projectile points according to the mathematical definitions. The applicability of Holmer's point typology and chronology to the Arizona Strip is supported by the two following observations: 1) dates on Holmer's point types are derived in part from stratified sites adjacent to the Arizona Strip in southeastern Nevada and southern Utah, and 2) the point types recognized by Holmer are directly comparable to projectile points from the Arizona Strip (Fairley et al. 1984; Moffit et al. 1978).

It is anticipated that Holmer's type descriptions and metric data will cover the range of variability for the majority of dart-size (Archaic) projectile points encountered on the Arizona Strip. It is important to realize that not all dart point morphological variability is accounted for by Holmer's typology. It is essential, therefore, to restrict the use of type names to those specimens fitting the criteria outlined by Holmer (1978, 1986). Not all points are can be typed; it is better to have points in an unknown category than to force them into existing types.

Although Holmer's dates may not be entirely appropriate for the Arizona Strip, his studies (1978, 1986) currently contain the most detailed information on the subject. His dates can serve as good first approximations that can be tested and refined as more chronological data becomes available.

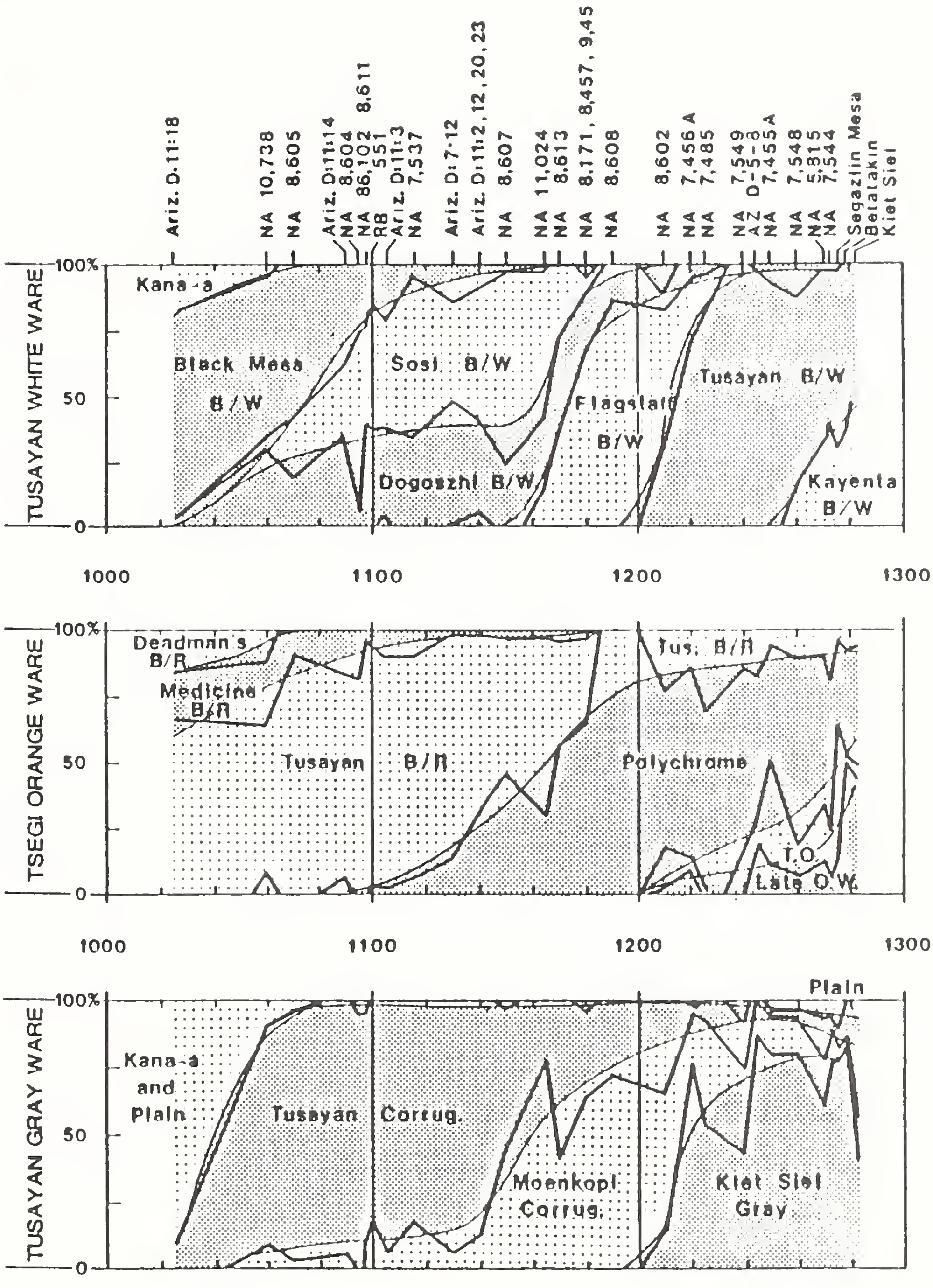


Figure 48. Cumulative frequency polygons and smooths for Kayenta pottery types, by ware. From Ambler (1985), with permission of author.

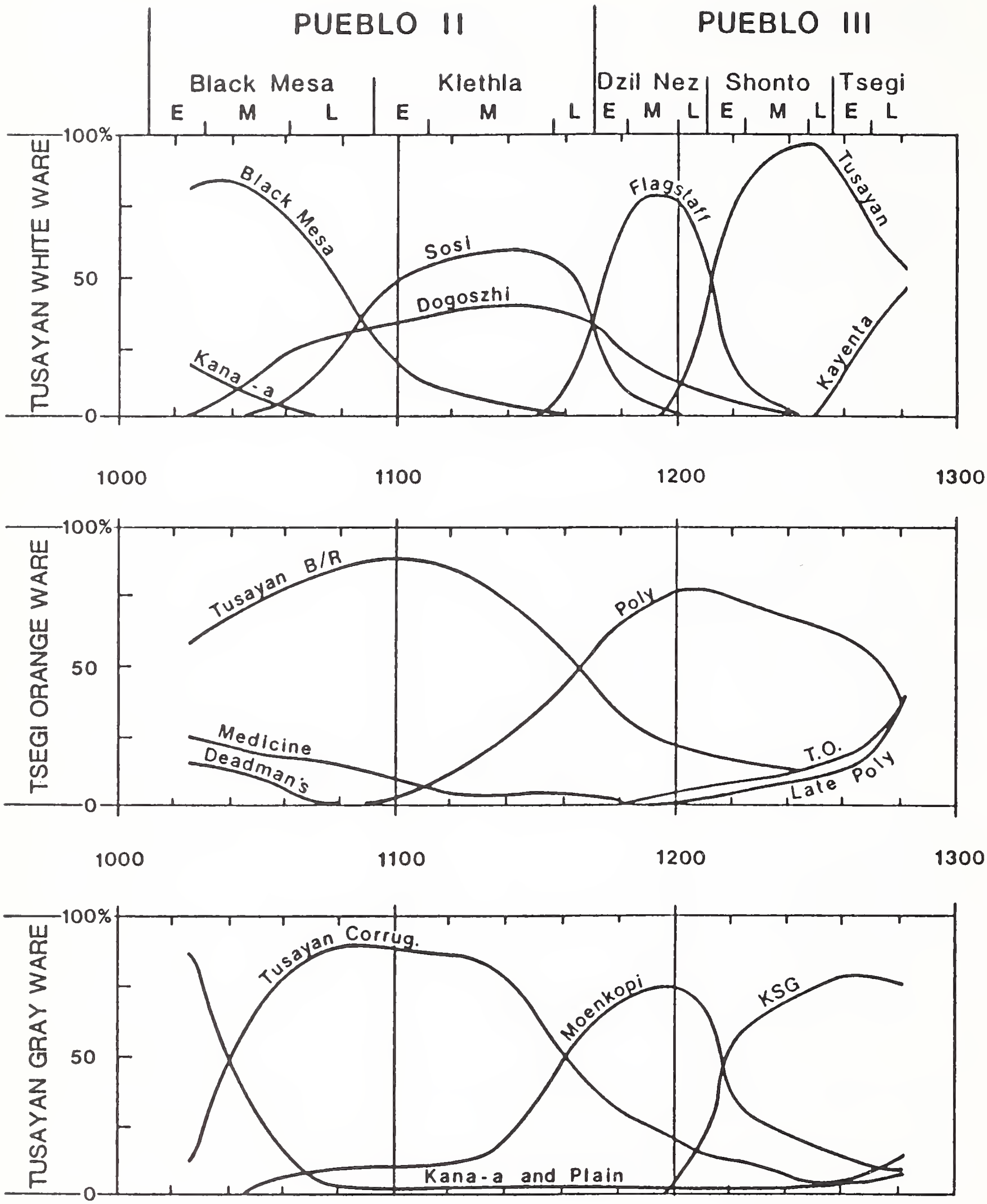


Figure 49. Individual type frequency curves and suggested phase divisions. From Ambler (1985), with permission of author.

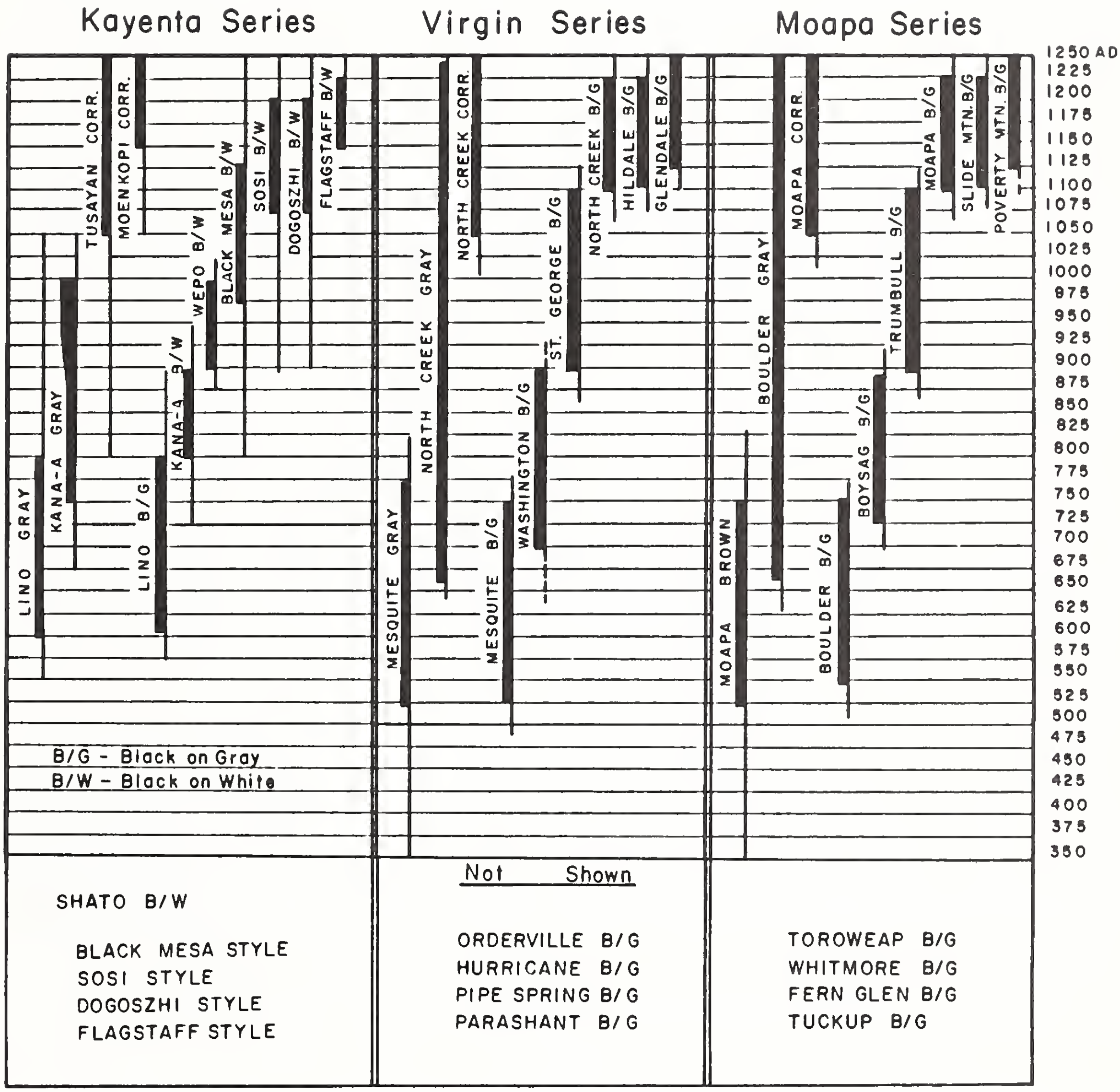


Figure 50. Types and suggested temporal spans of white and gray ware ceramics on the Arizona Strip (after Walling et al. 1987:352,355).

In contrast to Archaic dart points, no widely used objective typology exists for arrow points. A quantitative, consistent, and comprehensive arrow point typology is needed for the Arizona Strip, one that has clear archaeological utility, especially with reference to temporal or cultural variability. Creation of such a typology should be conducted on a regional basis and include points from both the Arizona Strip and from areas adjacent to the Strip. Until such a typology is developed, however, Holmer and Weder's (1980) type descriptions for arrow points from Utah would seem to be the best classification to employ on the Arizona Strip. It is certainly not exhaustive of potential point variability, but it is a published framework that is easy to use.

Other Dating Methods

Although generally less precise than radiocarbon dating, obsidian hydration, thermoluminescence, and archeomagnetism can provide alternative sources of chronometric information when perishable remains or charcoal are unavailable. As these techniques undergo continual refinements, they may eventually provide a supplementary means for evaluating chronometric data derived from the more commonly used dating methods described above.

Paleoenvironment

The constant and changing parameters of the Arizona Strip environment undoubtedly influenced patterns of human utilization through time. Climate, soils, water sources, and plant and animal resources are some of the critical environmental parameters that need to be delineated for each major cultural period before accurate reconstructions and models of human adaptation can be developed.

Questions

Paleoclimatic reconstruction is an obvious prerequisite for addressing questions pertaining to cultural adaptation and change. The extent of climatic alteration during the past 12,000 years is still open to debate. Even if one assumes that the fundamental configuration of climatic patterns on the Arizona Strip has not changed appreciably since the start of the Holocene, minor fluctuations of variable duration and limited spatial extent could have a profound influence on human adaptive patterns (Dean et al. 1985).

Questions about the paleoenvironment of the Arizona Strip include the following:

1) What were the major trends in terms of regional temperature and precipitation patterns during the past 12,000 years?

2) Were there any major deviations from the gross patterns that could have influenced human populations, and when did they occur?

3) What was the spatial and temporal extent of minor fluctuations?

Water is another important limiting factor to human occupation of the Arizona Strip. Water availability would have fluctuated in response to varying climatic regimes. During moist periods, water sources may have become more abundant, permitting occupation of less well watered areas. Drought, on the other hand, could have resulted in the dessication of springs and natural reservoirs, thereby necessitating major behavioral adjustments. With the advent of horticulture, water may have played an even more prominent role in structuring human activities in the region. Basically, we need to delineate the major types of water sources within the region, and determine what their temporal stability may have been.

The following questions specifically dealing with water sources on the Arizona Strip need to be addressed:

1) To what extent has the distribution of water sources varied through time?

2) Is there a patterning of site types in relation to various types of water sources?

3) If the answer to Question 2 is positive, does this patterning vary by time period?

The distributions of plants and animals upon which prehistoric peoples depended for food, fuel, and technological items is another factor that influenced human use of the Arizona Strip. For example, we need to address the following questions:

1) What were the spatial and temporal distributions of economically important species on both a long and short term basis?

2) Have the distributions of major plant communities changed appreciably through time?

3) How would these changing distributions have influenced human occupation and exploitation patterns on the Arizona Strip?

Data Needs

The types of data needed for reconstructing the paleoenvironment and examining its rate, tempo, and direction of change are discussed in Chapter 2.

Subsistence

The extraction of food from the environment constituted a central activity of prehistoric people. Virtually all other human activities were dependent upon meeting basic energy and nutritional requirements. Because material conditions of human life are directly affected by the abilities of man to feed himself (Price 1982), an understanding of prehistoric food procurement and processing practices and the nutritional status of prehistoric human populations is essential to furthering understanding of cultural processes (Steward 1955).

Questions

Basic questions pertaining to prehistoric subsistence patterns concern the staple plant and animal foods that were available during various time periods and the extent to which they were consumed. How were these foods procured? What were the methods of processing, storage, distribution, consumption, and discard?

For each major period, specific questions concerning subsistence can be raised. Many of these were discussed in the chapter on culture history and will not be repeated here. Instead, the research questions presented below are more general in scope and regional in nature.

1) Paleoindian period: (a) What faunal and floral species were present on the Strip when man first entered the region? (b) Was subsistence centered on the procurement of specific megafaunal species, and if so, were these fauna present in the area? (c) If not, what other faunal and floral species were exploited?

2) Archaic period: (a) What were the staple components of the diet? (b) Was Archaic subsistence focused and organized around the seasonal availability of a limited number of critical economic plants, or were consumption patterns less selective? (c) Did large mammals comprise a greater proportion of the diet relative to small mammals? (d) What was the relative importance of plants, particularly weedy species, in the diet? (e) Did the consumption of plant and animal species vary significantly through time, and if so, can these patterns be related to changes in environment or technology, or both?

3) Basketmaker II period: (a) When did the inception of plant cultivation occur on the Arizona Strip? (b) Was the introduction of horticulture tied to the migration of a distinct population into the region or was the technology introduced to a pre-existing population in the area? (c) How does the Basketmaker II consumption of cultivated species compare with that of the later Anasazi occupants of the Arizona Strip? (d) Are there significant differences between Basketmaker II and later populations in terms of general nutritional status?

4) Formative period: (a) What was the range of subsistence systems operating on the Arizona Strip throughout the Formative? (b) How important was agriculture in various parts of the Strip? (c) How did the subsistence focus affect sociopolitical organizations? (d) Did groups of horticulturalists and hunter-gatherers co exist on the Strip during the Formative and if so, were their subsistence systems symbiotic?

5) Neo-Archaic period: (a) How did subsistence strategies affect other aspects of culture? (b) How do archaeological data on subsistence compare with ethnographic models of historic Numic subsistence patterns? (c) Were there changes in Numic subsistence through time? (d) Did the subsistence strategy focus on one or more specific environments, and if so, which ones?

Data Needs

There are several appropriate avenues for exploring human subsistence patterns, and ideally they should be used in conjunction with one another. Primary data sources include fecal, macrobiological, palynological, and skeletal analyses.

Fecal Analysis. Undoubtedly one of the most reliable means for studying prehistoric subsistence is through fecal analysis. Not only do feces provide direct evidence of diet (Martin and Sharrock 1964), but they can also reveal information about the general health of prehistoric populations (e.g., Reinhard et al. 1985).

Human feces are occasionally encountered during survey in dry alcoves and other sheltered locations. Lacking secure provenience, such specimens need to be radiocarbon dated to make their analysis meaningful. For example, Stiger (1981) attributes feces found at one alcove site in the neighboring Glen Canyon region to Southern Paiutes based on their content and context. He offers a tentative comparison of Anasazi and Southern Paiute dietary habits based on these and other remains. Radiocarbon dating of selected samples would have verified the time of deposition, and by extention, the cultural affilation of the individuals responsible for their deposition. Given the wealth of dietary information that can be gleaned from fecal analysis, the surficial presence of desiccated human feces in sheltered contexts should provide sufficient cause for a determination of significance.

Stratigraphically controlled tests or excavations clearly offer the best context for studying fecal remains. A high priority should be given to the recovery and analysis of feces from subsubsurface investigations in sheltered locations on the Arizona Strip. When human feces are recovered, a full range of dietary analytical techniques should be employed (e.g., pollen, macrobotanical, bone, phytolith, fungal, and parasitological) in order to maximize the potential of this important data source.

Macrobiological Remains. Plant and animal remains are often visible on the surface of sheltered sites, particularly in disturbed contexts (e.g., pothunters' backdirt piles). Despite the lack of stratigraphic or temporal controls, the potential significance of surface remains should not be underestimated. For example, the presence of domesticates can provide a rough indication of the role of horticulture at specific sites or localities, while the presence of wild plant remains in areas where these plants do not presently occur can provide clues to prehistoric food gathering strategies or environmental changes. Observed remains should be carefully recorded, even though interpretation beyond a few basic statements is not advisable.

Flotation samples can provide more reliable quantifiable data on prehistoric subsistence behavior, although preservation and recovery biases must always be taken into account in the final interpretation. During survey, the most likely source of flotation data will be from hearth samples, as outlined under the discussion of radiocarbon dating. Flotation samples can also be efficiently collected during survey from ash lenses or features exposed in arroyo cuts. The age of such samples should always be verified through radiocarbon dating.

Most flotation samples will be obtained during testing and excavation projects. Hearths and middens should be extensively sampled; ideally, several liters of fill should be obtained from each strata within a midden, and the entire contents of hearths should be collected. The contents should be processed using standard techniques, and all carbonized seeds, woody plant parts, and faunal remains identified. Samples of wood charcoal should also be submitted for identification as these may help in reconstructing past woodland distributions, fuel wood use patterns, and paleoclimate.

Pollen. Interpreting prehistoric subsistence patterns from pollen remains is a complicated task due to the preservation and recovery biases inherent in this medium. Nevertheless, palynological analyses can provide information on certain classes of plants that are not readily preserved elsewhere in the archaeological record. Therefore, it is most useful to employ this analytical approach in conjunction with other techniques to provide corroborative and supplemental information. In principle, pollen samples should be collected whenever a flotation sample is obtained. Because hearths are notorious for their poor pollen preservation, it is probably not worthwhile to collect pollen from such features. Once again, standard processing and analysis procedures (e.g., Kummel and Raup 1965) should be followed.

Skeletal Remains. There are a variety of methods for analyzing human osteological remains that can provide additional data for inferring prehistoric subsistence practices (e.g., Buikstra and Cook 1980; DeNiro and Epstein 1978, 1981; Van de Merwe 1982). The extensive skeletal collection recovered from the excavations along Highway 395 (Wade 1967) is one potentially important source of information relating to Virgin Anasazi subsistence that has not been investigated to date.

Technology

The acquisition and processing of raw materials into tools, structures, and apparel is an essential aspect of human adaptation during all time periods. Indeed, studies of prehistoric technologies form a cornerstone of archaeological research. Technological studies not only provide essential information on man's adaptation to his environment, but they also enable investigators to pursue questions concerning exchange, ethnicity, and culture change.

Questions

On a general level, archaeologists need to determine which biotic and geologic resources were used during various time periods, how their extraction was organized, and how they passed through the cultural system. Questions that need to be addressed for all periods include the following:

1) What geologic resources are currently available in various areas of the Arizona Strip, and how has the spatial distribution of these resources influenced their use?

2) Have patterns of lithic material exploitation and usage changed through time?

3) What do the debitage attributes of lithic assemblages tell us about the technological capabilities of the manufacturer(s), and what do they indicate about the organization of lithic manufacturing activities?

4) What are the characteristics of the various tool kits used in resource procurement, lithic maufacturing, food processing, and other activities?

5) Were specific plant species favored for constructing particular items during various time periods?

6) What techniques were employed in manufacturing different classes of basketry and textiles, and how did they change through time?

Several questions pertain specifically to the Formative and Neo-Archaic periods:

1) How did the development of ceramic technology affect food processing and consumption patterns? For example, Glassow (1972) maintains that ceramics were introduced with beans as part of a single complex, because ceramics facilitated the soaking and boiling process required for the preparation of beans. Can this correlation be verified on the Arizona Strip?

2) Did the introduction of ceramic containers affect other aspects of prehistoric cultural systems? For example, did the introduction of water ollas (which allowed greater quantities of water to be stored) result in settlement shifts?

3) Are there distinctive aspects of Neo-Archaic technology that would indicate a competitive advantage over the earlier Anasazi technology? For example, are items indicative of intensive seed exploitation, such as parching trays and seed beaters, restricted to the Neo-Archaic period on the Arizona Strip, as Bettinger and Baumhoff (1982) maintain is the case for the Great Basin region?

Data Needs

A primary step towards elucidating prehistoric technological systems involves the delineation of accessible raw material sources. One concern should be directed at geologic materials such as clays, various rock types, and mineral pigments, since the present spatial distribution of these materials is essentially the same as when they were exploited in prehistory. Essential to this process is the collection of samples from various rock formations within the region to build resource files that encompasses the range of physical variability within resource types.

Another important concern is to document the distribution of various lithic materials in the archaeological record. During site recording, archaeologists must pay attention to the amount and diversity of various lithic materials at the site, and the conditions of occurrence. For example, noting the presence of obsidian at a site does little to further our understanding of technological behavior. Does the obsidian occur in nodular form, as large flakes with cortex, as tiny thinning flakes, or as finished tools? These more detailed observations permit inferences regarding patterns of resource procurement, manufacturing strategies, and exchange.

Field archaeologists also need to devote more attention to the nature of lithic debitage at sites. Are most flakes derived from core or biface reduction, or from early or late stages of a tool production sequence? How common are various flake size categories? What types of flakes occur most commonly in various materials? The collection of this information can be facilitated by judgementally or randomly selecting one or more areas of the site and tabulating the artifacts contained within the units by material, size, amount of cortex, and other relevant variables. In combination, this information can reveal a great deal about the nature of tool manufacturing activities conducted at sites.

Both architecture and artifacts provide information on the relative permanency of occupation, as well as information relating to seasonality of occupation, subsistence activities, size and organization of social groups, and the spatial organization of activities. One way to measure the permanency of occupation is to evaluate the amount of energy invested in the construction of dwellings. Are the construction materials shaped in any fashion? Are the foundations carefully prepared? Are storage features present? The presence of storage features implies storage of surplus seeds, and in association with habitation sites, may be another indication of year-round occupation. Similarly, attention should be paid to the nature of materials employed in the construction of features. Were construction materials carefully selected and imported from a distance off site, or were materials available in the immediate vicinity of the site employed? Observations on the types of materials used, their local availability, and any indication of pronounced investment in construction techniques (shaped blocks, patterned use of chinking stones, etc.) should be carefully noted on site records.

Settlement Patterns

Humans select locations for conducting specific activities based on various criteria such as proximity to critical resources, degree of exposure, defensibility, or view. The importance of these various attributes may vary according to the type of activity performed at the site. Thus, the study of site types and their distribution across the landscape through time can provide archaeologists with important clues about prehistoric subsistence strategies, social organization, and other aspects of behavior.

Questions

The basic question regarding settlement patterns is still, "where are sites located and why are they located there?" This question, in various forms, has been the central focus of studies in Grand Canyon (Euler and Chandler 1978) and the Mount Trumbull area (Moffitt and Chang 1978). Predictive models also address this question although the concern tends to be more management based. The following questions are fundamental to any attempt at modeling site locational behavior:

1) Do site locations covary with environmental factors? If so, which factors are most important?

2) What do site layouts and the patterning of sites across the landscape tell us about socioeconomic and political organization?

Data Needs

There are many facets of and techniques applicable to the analysis of prehistoric settlement organization. Fundamental to all endeavors is actual field recording and locational plotting of sites. Concerning the latter, the use of aerial photographs is strongly recommended, particularly because finalized 7.5 minute topographic quadrangle maps are not yet available for the entire Arizona Strip. Site locations should be transferred to archival maps following completion of the field work. Sites measuring more than 50 m in diameter should be delineated on the map by drawing in the actual boundaries of the site, rather than by plotting a single dot. Symbols may be useful for distinguishing different site types.

Site recording on the Arizona Strip has been anything but consistent. A wide assortment of recording forms have been used in the past, and the resulting quality of the available information is highly variable. Currently, the three land management agencies use different recording forms: the National Park Service uses a form originally developed for the Southwestern Archaeological Research Group (SARG) project (Euler and Gumerman 1978), the USFS uses a combination computerized and narrative form designed to be applicable to the entire Southwest region, and the BLM has recently adapted the AZSITE form from the Arizona State Museum. In addition, private researchers have used their own field inventory forms. Each of these forms has positive and negative attributes; none are ideal. Currently, there appears to be a trend towards adopting the AZSITE form for all of Arizona. If this becomes reality, a greater degree of uniformity would be achieved. Nevertheless, this particular form is probably the least informative of all the ones currently in use on the Strip, and it is certainly the most difficult one to use for research purposes.

A primary drawback of the AZSITE form is the lack of a standardized site typology. Although the consistent assignment of sites to functional classes is beset with difficulty, especially when dealing with survey data, site classification does serve as a useful means for organizing data and as a framework for the initial recognition and interpretation of subsistence settlement systems. The criteria used in this overview for categorizing existing site data from the Arizona Strip is presented in chapter 7. However, this typology was severely constrained by the variable quality and amount of data that could be gleaned from existing site records. Ideally, a two part site typology comprised of a descriptive category and a functional interpretation offers the most versatile means of categorizing site types (e.g., lithic scatter; specialized activity: quarrying).

In the end it really does not matter which form is used as long as it is used well. The main concern is not with inadequate forms but inadequate field recording. Having reviewed all site forms for the Arizona Strip, it is evident that poor recording is the norm, not the exception. The places for narrative description are sometimes left blank, and are rarely filled in with sufficient detail. This is unfortunate since they provide a better overall impression of a site than the often poorly conceived fill-in-the-blank categories. Although site sketches should be standard, they are too often omitted or are so poorly drawn as to be useless. Also, no matter how good the site form, there is no substitute for a seasoned field archaeologist with an intimate working knowledge of the environment and local archaeology. A few weeks of training might produce a paraprofessional capable of doing small-scale compliance work, but a paraprofessional is no subsistute for a well trained archaeologist.

Paleodemography

Several broad avenues of inquiry are pertinent to prehistoric demographic studies. First, population numbers and densities within the region as a whole and within specific localities are critical factors in the study of cultural adaptation and change. Of primary importance is population size in relation to the energy base within the limitations set by subsistence practices and technology. Deriving absolute numbers of people present in any one site or area from prehistoric data is extremely difficult, if not impossible; however, the determination of relative population frequencies is feasible (Hassan 1981). Reconstructing vital population characteristics such as health, nutrition, age structure, survivorship, and sex can contribute greatly to our understanding of many important research issues. The physical (genetic) characteristics of populations can also tell us about ethnic boundaries, group affinities, and migrations.

<u>Questions</u>

1) Within the Arizona Strip, what was the relative population size during various time periods?

2) How was the population distributed during various time periods?

3) From what did population fluctuations within the Arizona Strip result (growth, migration, disease, starvation, etc.)?

4) What were the nutritional and health characteristics of populations during various time periods?

5) What were the age and sex structures and mortality rates of populations during various time periods?

6) Can changes in population characteristics be related to subsistence settlement changes or to other factors?

7) Can different (genetic) populations be discerned either spatially or temporally from comparisons of skeletal materials?

Data Needs

There are two broad classes of data applicable to the study of paleodemography: site characteristics and skeletal remains. Large amounts of data are necessary for addressing this research issue on a regional scale and it may be many years before sufficient information has been accumulated for this purpose. Nevertheless, it may be possible to address this issue in a preliminary fashion within limited areas of the Strip where intensive surveys have already been conducted, and by analyzing the skeletal remains already in hand from previous excavations in the area.

Critical to any undertaking of this nature is the establishment of contemporaneity, either of sites or of skeletal remains. A fine-grained analysis is obviously not possible at the present time, due to the inexact nature of temporal controls for the area, but comparisons between broad temporal units (e.g., early Formative vs. late Formative) may be feasible.

Other major obstacles to paleodemographic reconstructions concern the definition of site function and the estimation of room counts and habitation room size from survey data. Studies carried out by archaeologists working on Black Mesa in northeastern Arizona demonstrate that there are statistically reliable correlations between surface characteristics and subsurface remains that can be useful for establishing site function (e.g., Powell and Klesert 1980). Although these findings may be applicable to the Arizona Strip, this must be established independently using excavated site data from the Arizona Strip. In a similar vein, it may be possible to develop a reliable means of estimating habitation area at unexcavated sites through comparisons of surface feature measurements (e.g., roomblock area) with more precisely measured room areas from excavated sites. Using site date from Black Mesa, Layhe (1981) illustrates how regression analysis may be applied towards this end. Only after these kinds of baseline studies have been completed using local data sources can we begin to address the issue of prehistoric population growth and decline on the Arizona Strip.

Cultural Boundaries and the Definition of Ethnic Groups

Most attempts at defining cultural boundaries in the northern Southwest have approached the problem as if it were simply a distributional one (e.g., Colton 1939, 1942; Lister 1964). The quantities and diversity of various artifacts and architectural styles in time and space have served as the primary source of data for defining ethnic entities and boundaries. This established practice of assuming a one-to-one correlation between material culture and ethnic group definition is suspect on both theoretical and empirical grounds. Before we can evaluate the meaning of distributional patterns, a basic question needs to be answered: Does material culture have theoretical relevance for distinguishing ethnic groups? Barth's (1969) suggestion that the existence of ethnic groups depends on the development and maintenance of social boundaries provides one possible means for answering in the affirmative, because material items provide one obvious way of demarcating social boundaries. Furthermore, these socially defined boundaries are likely to be expressed in terms of community organization patterns and religious practices, which in turn may be reflected in site layouts and ceremonial features.

The delineation of the specific aspects of material culture that convey cultural information (Hodder 1978, 1982; Weissner 1983; Wobst 1977) is the first step towards defining ethnic entities. Spicer (1971) suggests that such carriers should have symbolic content. Symbols can be either public or private; the former serve to publicize and reinforce the existence of ethnic boundaries within the group as well as in relation to outsiders, while the latter function in a unilateral sense to foster ingroup cohesion. Weissner (1983) summarized aspects of the theoretical basis for identifying which items of material culture might express cultural identity and which attributes or items might be most profitably analyzed in this regard. In terms of Arizona Strip archaeology, these might include public symbols such as rock art and ceramic design styles, as well as non-public symbols such as features in living room interiors.

Questions

For each period in prehistory, several basic questions pertaining to the issue of cultural boundaries and ethnicity need to be addressed.

1) Who, in the sense of ethnic groups defined by material traits, occupied the Arizona Strip during specific temporal intervals?

2) Did different ethnic groups occupy the Arizona Strip contemporaneously?

3) What was the spatial extent of various ethnic groups during particular time periods?

4) What were the nature of boundaries between various ethnic populations, and how were they maintained?

5) What symbols did various ethnic groups use to delineate their territorial boundaries and maintain or express their identity?

Data Needs

Material Culture. Material culture is only one of many ways in which ethnicity is exemplified, yet it is the most accessible data source for archaeologists. When examining past analyses of material culture from the Arizona Strip two essential questions must be addressed. First, have classification schemes been consistently applied? Second, has there been inter-analyst agreement? To both questions, the answer is probably no. This situation seems to be mainly the result of divergent points of reference by previous and current researchers in the area. The Arizona Strip has, in a sense, been a frontier zone for archaeologists with different regional training and perceptions. A Dogoszhi Black-on-white sherd, common to someone experienced in Kayenta archaeology, might be an unidentifiable black-on-white to a Fremont archaeologist. Conceptual and classifactory confusion also pervades other aspects of material culture such as architecture. Initial efforts must be directed at attempting to clarify typological confusion of ceramics and projectile points--no small undertaking. This task has already been initiated to some extent (e.g., Acker 1983; Walling et al. 1986), but much work remains to be accomplished. In the meantime, it is important that consistency be maintained in artifact classifications. This is best accomplished by restricting the application of type names only to those artifacts that meet all of the defined attributes of the existing type description (e.g., Colton 1952, 1955; Holmer 1978; Holmer and Weder 1980; Marshall 1979) and using descriptive categories for the remainder.

Architecture. In addition to ceramics and lithics, architectural variability provides another means for identifying cultural affiliations. Certain construction techniques or styles seem to have been preferred by certain cultural groups, and these could prove important for documenting cultural boundaries. Features such as the presence or absence of entrybox complexes or the method of hearth construction (clay-rimmed vs. slab-lined), are obvious examples. Site layouts can also indicate ethnicity by revealing aspects of internal community organization, and indirectly, social structure. Before we can hope to identify the sources of the stylistic "blueprints" manifested in the architecture of the Arizona Strip region, however, we need to know the stylistic norms and range of variability in the architecture of the Arizona Strip and adjacent areas. Without this basic data, questions concerning the broader issues of cultural/ethnic affiliations, the degree to which Arizona Strip populations were influenced by those of surrounding regions, the relative importance of style versus functionality, and a host of related research topics will remain unanswered. To acquire these data, systematic and consistent documentation and quantification of architectural styles and construction techniques within the Arizona Strip are needed.

Rock Art. Inherently symbolic in content, rock art can provide insight into the ideological realm of a cultural system. A shared repetoire of design elements, figure types, figure complexes, and aesthetic modes constitutes an artistic style (Schaafsma 1980:9). The uniformity of various rock art styles over a given geographical area can inform archaeologists about the regional extent of a particular ideological system and at the same time delimit the boundaries of prehistoric information exchange networks. Regional variations within a given style and the geographic limits of those variations can in turn provide information about regional variations within a culture (Schaafsma 1980:8).

Several distinctive rock art styles have been recognized on the Arizona Strip. Major styles include a western variant of the Barrier Canyon style (Schaafsma 1988), an unnamed style consisting of large anthropomorphs that shares characteristics with both Fremont and Basketmaker II-Anasazi styles, a Cave Creek style, and eastern and western variants of a Virgin Anasazi style. These styles seem to be associated with the mid- to late Archaic, late Archaic-Basketmaker II, Basketmaker III-Pueblo I, and Pueblo II-III periods respectively (Schaafsma 1971:125-126, 1988). With additional data, it might be possible to refine these stylistic divisions even further, but this will require far more detailed recording of rock art sites than has been done in the past. Site records of the American Rock Art Research Association provide an ideal example for archaeologists to follow; however, if time and financial limitations do not permit such detailed recording, at a minimum a number of photographs with measured scales, supplemented by sketches of the art and a site plan showing the locations of the panels should be obtained.

Skeletal. Another potentially informative avenue of inquiry in the realm of ethnic/cultural group definition and boundaries deals with genetic similarity or dissimilarity expressed in human skeletal series. Studies have shown that both nonmetric and metric cranial traits can be used to document population affinities (e.g., Berry 1974; Bielicki 1962; Corruccini 1972, 1974; Mackey 1977; Neel and Ward 1970; Rhoads and Friedlaender 1975). Cranial traits could be profitably compared and contrasted in the Arizona Strip during various time periods, and between the Arizona Strip and those of surrounding "cultural regions."

Interregional Interaction and Exchange

Socioeconomic interaction and artifact exchange is one mechanism through which cultural contact is mediated and localized resource imbalances are equalized. Fortunately, this process leaves a material residue in the archaeological record.

Questions

For any given temporal interval, certain basic questions must be addressed. Specifically, we need to know what items were exchanged at various temporal intervals and in what quantities. We also need to determine where these items originated. With this basic data in hand, regional research issues can be addressed. Specifically, we need to ask the following:

1) During each temporal period within a given locality of the Arizona Strip, what does the distribution of non- local materials tell us about the nature of exchange patterns, and what models of exchange (e.g., Renfrew 1977) best fit the existing data base?

2) What were the mechanisms and intensity with which different populations and groups interacted?

3) Can changes in the directions of interregional interaction be detected through time?

4) Do shifts in intra- and interregional spheres correlate with changes in other apects of the existing cultural system?

Data Needs

Ceramics. If ceramics are to be useful both as temporal and cultural indicators and as evidence of exchange, then consistency in their classification and analysis over the entire Arizona Strip is vital. It is important to employ an analytical classificatory scheme that is sufficiently sensitive to allow for the identification of ceramics produced in different regions, if not within specific localities of a given region. Primary reliance must be placed on attributes of paste, temper, and slip/paint treatments. These attributes are in large part dependent on the differential availability, access, and knowledge of geologic materials. Consequently, they can be related to specific areas of ceramic manufacture, given an understanding of resource distributions (see above discussion of technological resources under paleoenvironment data needs). The degree of spatial resolution will vary according to both the kinds of materials and manufacturing techniques employed in pottery production and our knowledge of these aspects.

Until the late 1970s, ceramic analyses conducted on the Arizona Strip were primarily oriented towards fitting sherds into Colton's (1952) typological classification. Over the years, a considerable amount of time and energy has been wasted on pointless arguments over whether a particular sherd should be classified as a Shinarump Ware, a Virgin Series Tusayan Ware, or something else. There is an evident lack of consistency in the manner in which Colton's types have been recognized, and this seems to be a direct reflection of the fact that Colton's classification does not account for the full range of variability in the ceramics of the Arizona Strip. Furthermore, there seems to be considerable overlap in the distinguishing characteristics of the Virgin Series of Tusayan Gray and White wares, the

Shinarump wares, and the Moapa wares (Thompson 1971a; Bond 1987). Perhaps what is needed at this point it a total reorientation of ceramic analyses focused on the differentiation of local ceramic production zones.

The identification of a ware as Shinarump or Tusayan adds nothing to our understanding concerning the origin of that particular sherd. The identification of an olivine-tempered sherd as a Moapa ware suggests a somewhat more restricted origin, based on the common assumption that the olivine temper originated from Mount Trumbull (e.g., Weide 1978); however, recent studies by Lyneis (personal communication 1988) suggest that in some cases olivine temper, rather than whole pots, may have been traded. Furthermore, Lyneis has found evidence that olivine tempered pottery was recycled by potters in the Lost City region. Thus, the presence of olivine temper per se cannot automatically be assumed to be indicative of production in the Mount Trumbull region.

As a first step towards differentiating ceramic production zones, analyses must be sufficiently fine-grained to separate classes of ceramics according to temper and paste attributes. Microscopic examination of the temper constituents in combination with refiring of sherds provides a preliminary and efficient means of distinguishing temper and clay groupings. This approach has already been initiated on the Arizona Strip to a limited extent (e.g., Blinman 1987; Bond 1987; Lyneis 1986a; Warren 1980; Wilson 1985) and the initial results appear promising.

Pottery Resources. For determining localities of ceramic manufacture, as many quantifiable tests as possible on both raw clays and the prehistoric ceramics should be performed (Arnold 1985). Simple techniques such as microscopic examination of temper and the firing of raw clays and refiring of prehistoric sherds at standardized temperatures should be routinely used. The more expensive tests, such as petrographic analysis of tempers and chemical characterization of clays and tempers, should be used only on carefully selected samples to address specific research questions.

Clay: An initial assessment of clays from geologic deposits within the neighboring Kayenta region has revealed some clear distinctions that are useful in understanding ceramic origins and distribution patterns (Deutchman 1979; Geib and Callahan 1987). The distinctions between and among certain clays in the Kayenta region may be generally applicable to the Arizona Strip because many of the geologic formations that Geib and Callahan (1987) studied also occur within the eastern part of the Strip, as well as in areas immediately to the north. If chemical distinctions between various clay deposits can be made, then we are in a better position to use ceramics for more than just temporal ordering. The basic step in this process is the collection of enough clay samples to enable us to build a materials file that covers the range of variability of important clay characteristics within the Arizona Strip region. Field sampling is best done in a systematic fashion, but when funding is not available for such an endeavor, sampling can be performed coincident with archaeological survey whenever potential clay resources are encountered. The specifics of source location, geologic context, sampling procedure, and other information for collected specimens should be detailed on a clay source recording form. In this way a record of known clay deposits, along with examples of each deposit, can be compiled for various analyses.

Temper: Like clays, the usefulness of temper analysis in archaeological research is in part dependent upon documenting where geological sources of various tempering agents occur. This has already been accomplished to a limited extent (e.g., Weide 1978; Lyneis 1981), but considerably more work is needed. In general, it is usually best to field sample for temper after obtaining a good idea of what rock types were actually being used as pottery aplastics. Information concerning geologic context, location, and sampling procedures should be documented on a standardized field recording form.

Slips and Paints: These items are moderately rare occurrences in geologic deposits and, therefore, are often highly valued and coveted. Usually only small amounts are needed for ceramic decoration, allowing for paints and slips to be exchanged over considerable distances even in simple societies (e.g., Arnold 1981, 1985). As a result, they are not as reliable an indicator of place of manufacture as tempering agents and clays. Nevertheless, knowledge of their geologic outcrops and physical/chemical characteristics are important. For these reasons clay slips and mineral paints should be collected and recorded when found according to the procedures outlined above for clays and tempers respectively.

Lithic Resources. The category, lithic resources, refers to rocks that were utilized for artifacts, no matter if their production involved flaking, pecking, grinding, or some combination thereof. A detailed assessment of lithic resources available on the Arizona Strip needs to be conducted. Essential to this process is the collection of enough lithic samples in order to build a lithic resource file that covers the range of physical variability within resource types. Silicates are not the only materials that need to be sampled and described; data on sedimentary, igneous, and metamorphic rocks are equally important. Field and initial laboratory observations for each sample should be recorded on a standardized form. Even without undertaking a detail assessment of locally available lithic resources, it may be possible to distinguish certain imported lithic materials based on distinctive macroscopic characteristics. Two obvious examples are obsidian and turquoise, neither of which occur naturally on the Arizona Strip. Preliminary studies by Lesko (1987) and BLM archaeologist, Richard Malcolmson (personal communication 1987), demonstrate that obsidian was imported to the Arizona Strip from the Government Mountain and Mount Floyd areas south of the Colorado River, as well as from the Modena area in southwestern Utah. The next step should involve more fine-grained analyses, which define the temporal occurrence of these various obsidian sources. This information could then be used to establish a more precise understanding of the changing nature of prehistoric exchange systems on the Arizona Strip.

CONCLUSION

Although general understanding of Arizona Strip prehistory has improved dramatically since Judd's initial forays into the area, there are still numerous geographical, temporal, and topical data gaps that remain to be addressed. The foregoing section has attempted to point out some of the issues that require study, highlighting the gaps that are most crucial to furthering our understanding of Arizona Strip prehistory.

The lists of research questions presented in the foregoing pages are by no means exhaustive. They merely serve to illustrate the extent of current ignorance concerning the cultural history of the Arizona Strip. For some of the questions listed above, we have sufficient information to formulate some tentative hypotheses. For most of them, however, the answers remain elusive. It will require a concerted effort on the part of the three federal land managing agencies, in cooperation with the larger archaeological community, to initiate a comprehensive approach to studying, managing and interpreting the cultural resources of the Arizona Strip. This preliminary research plan is an initial step in that direction.

PART II

THE MANAGEMENT OF CULTURAL RESOURCES ON THE ARIZONA STRIP

CHAPTER 7

THE DATABASE

Jeffrey H. Altschul

One of the great problems in conducting research on the Arizona Strip is that there is no central repository for data pertaining to the region. This problem is not exclusive to the Arizona Strip but applies equally well to all parts of Arizona. The decentralized nature of data collections in Arizona stems from the long history of archaeological research in the state by separate institutions. Prior to the advent of computerized databases in the late 1960s and early 1970s, there was no strong advocate for centralizing the various data collected by different institutions. Unlike the states that followed the Smithsonian system of numbering sites, which by its nature demands a single focal point for dispensing site numbers, Arizona's institutions by-and-large followed their own initiative.

The most influential site numbering and recording system is the one developed by Gila Pueblo and then adopted by the Arizona State Museum (ASM). This system divides the state into 32, 1 degree blocks, each of which is given a sequential, alphanumeric designation (i.e., from the northwest corner quads are labeled A, B, C, and so on to FF in the southeast corner of the state). Each block is then divided into 16 15-minute quadrangles, numbered sequentially from northwest to southeast. Within each block, sites are assigned numbers in sequential order. Thus the first site recorded in the ASM system for the northwesternmost corner of the state would be numbered, AZ A:1:1.

The ASM system is used by most state institutions, although the system is not centralized in any one institution. This confusion is most apparent between the two major state institutions, the Arizona State Museum and Arizona State University (ASU). Each institution numbers sites the same way, but keeps its own site records independently. Thus, if both institutions record sites in square AZ A:12, they will both reference the first site they record as AZ A:12:1 even though they may not (and usually are not) referencing the same site. To keep their records straight, each institution appends a suffix to their site numbers. In the above example, the ASM site would have the number AZ A:12:1 (ASM) while the ASU site would be recorded as AZ A:12:1 (ASU).

Although the ASM system is used by the two major state institutions, it is not generally employed by other private institutions or federal agencies that have worked on the Arizona Strip (Table 6). The Forest Service not only has a separate site numbering system, but also has created its own computerized database. The BLM has recently converted to using its own version of the ASM system and does subscribe to the quasi-official state computerized database, AZSITE. The Museum of Northern Arizona (MNA) and Northern Arizona University (NAU) do not use the ASM system and do not subscribe to AZSITE. NAU maintains its own customized computer system, and MNA has no computerized database at all. The National Park Service follows two systems. The Lake Mead National Recreation Area (LMNRA) is under the administration of the Western Archeological Conservation Center (WACC) in Tucson. WACC has assigned ASM site numbers to all sites in the LMRA and subscribes to AZSITE. The Grand Canyon National Park, in contrast, follows their own variant of the ASM system, and uses a number of database systems. Of the 2,306 sites recorded in the Grand Canyon (half of which are on the Arizona Strip), data from 843 are presently on the SARG database at ASU (Janet Balsom, personal communication, 1987). Management information on all of the sites has been placed on personal computers using the LOTUS software package. The park is presently in the process of converting all site data to DBASE III+ files.

Table 6. Major Institutions Working on the Arizona Strip.

Institution	Site Numbering System	Computerized Database
Arizona State Museum	ASM	AZSITE
Bureau of Land Management	BLM (ASM variant)	AZSITE
Western Archaeological Conservation Center	AZSITE	AZSITE
Grand Canyon National Park	NPS	SARG, LOTUS
Forest Service	USFS	USFS
Museum of Northern Arizona	MNA	None
Northern Arizona University	NAU	NAU

To compile all available site data from the Strip would be a monumental task. Although this overview moves closer to this goal, it by no means accomplishes it. For this project we concentrated on the two major databases: AZSITE and the USFS computer database. The reasons for this concentration were twofold. First, it was simply beyond the scope of this project to collect all the site forms pertaining to the Arizona Strip and code and place them on a computer. Second, the sponsors of this overview, the BLM and the Forest Service, were primarily concerned with examining their databases.

To the uninitiated, it may appear that extracting useful data from computerized databases would be a relatively simple task. All one has to do is to enter the proper request and the information automatically appears. In practice, the process is somewhat more complicated. The basic problem with using any large database that incorporates data recorded by many people over many years is assuring the accuracy and reliability of the information. Different investigators view the same site from distinct perspectives, which often results in similar phenomena being classified into different site types. Further, as more information is collected, changes in chronology occur that can alter a previously recorded site's temporal affiliation.

To overcome these problems, we adopted a conservative approach. We re-evaluated every component recorded in the AZSITE database and the Forest Service CRM database that was located on the Arizona Strip, utilizing both the information in the computer files and on the original site record. For prehistoric components this re-evaluation focused on three basic site attributes; site type, temporal affiliation, and the degree of shelter. Prior to conducting the re-analysis, a codebook was devised that listed the criteria for each 'legal,' or acceptable, value of a variable (Appendix 2). These criteria were unambiguous and nonoverlapping. For each variable, a component could be assigned to one and only one score. To assure consistency, the entire evaluation was conducted by only two individuals working very closely with each other. Although some may disagree with our site categories or temporal breakdown, there is absolutely no question that our classification has been applied in a consistent fashion over the entire Arizona Strip.

The classification developed for this project clearly places us among the "splitters" as opposed to the "lumpers" in regards to typological approach. Thirty-one site types and 24 temporal classes were defined. Seventeen of the site types related to components that, on the basis of the surface evidence, are inferred to have been used as habitations. Fourteen of these types related to components containing structural remains, while the remaining three contained an artifact and feature assemblage that we associated with base or temporary camps. Limited Activity site categories included artifact scatters (3 classes), isolated features (5 classes), and specialized activity sites, such as quarries or agricultural features. The remaining three site types referred to other kinds of specialized activity sites (e.g., shrines), limited activity sites that could not be further classified, and components that could not be classified to any site type (i.e., no data on the site form).

Components were classified to the most specific temporal period possible. For example, many components could only be dated to the Formative period on the basis of the artifact assemblage. Some could be further classified to "late Anasazi" (i.e., Pueblo II-early Pueblo III), while others still could be more precisely dated to "Late Pueblo II." To obtain information on which sites were simply dated to the Formative, one has to select codes 20 through 30; to find out which sites are "Late Anasazi" one needs to extract information on codes 23 through 30; and to examine only sites that can be clearly assigned to Late Pueblo II, site information from components coded 26 needs to be obtained.

We understand the typology is somewhat cumbersome. We believe, however, that given the nature of the database, this classification is appropriate. Our objective was not simply to prepare data for this project. Instead, we wanted to create a database that others interested in different issues could use as well. To do so, we decided that the categories had to be relatively fine-grained. The result for the temporal classes is a series of hierarchically overlapping categories that can be lumped into more inclusive time periods or split into succeedingly finer divisions.

For historic components, the re-evaluation was less complicated. Historic components, which in this report refer solely to Anglo-American remains, were classified in one of five categories: habitation, industrial/economic, trash disposal, rock art/survey markers, and unknown. Habitation components were defined as those that were clearly used as living quarters. Industrial/economic refers to a diverse set of components, which reflect any type of exploitive or processing activities. These components range from copper mines to sheepherders' camps. A third site class consists of isolated historic trash dumps. Historic rock art and survey benchmarks were grouped together in a fourth site class because in many cases both were designed to convey spatial information. Indeterminate historic components, then, constitute a final fifth site class.

Temporal and functional data were re-evaluated for this project. The same cannot be said for the following site information: location, National Register/State Register status, site condition, and the status and nature of site collections. These data were obtained straight from the databases. As such, we have no control over recording or coding errors. Although the general trends shown by these dimensions over the entire Strip are probably valid, individual scores should be viewed with caution.

GENERAL TRENDS IN THE DATA

Between AZSITE and the Forest Service CRM database, there are 2,597 prehistoric and 163 historic sites recorded on the Arizona Strip. Among these sites there are 2,850 components represented. Including the sites recorded in the Grand Canyon National Park, in the MNA site files, and various other small collections, a conservative estimate of the total of known sites recorded on the Arizona Strip is around 4,000.

One indication of the intensity of work on the Arizona Strip by major institutions and agencies is the number of site numbers each has assigned (Table 7). In interpreting Table 7, several additional facts need to be kept in mind. First, the National Park Service (NPS) sites are greatly underrepresented. Data in the AZSITE system presumably represent sites recorded at a time when the forms were sent to ASM. As stated above, the Grand Canyon National Park keeps its own records, whereas WACC has allowed ASM to assign site numbers to all sites (except one) in the Lake Mead National Recreational Area. Indeed, most site numbers assigned by ASM on the Arizona Strip represent NPS activities. Finally, sites assigned by MNA represent two major surveys, those conducted on the Paria Plateau and on Mount Trumbull. The numbers were actually assigned by the BLM and attributed to MNA. These sites reflect a large proportion, but not all, of the work MNA has conducted on the Arizona Strip.

Table 7. Site Numbers Assigned by Institutions Working on the Arizona Strip.

Institution	Number
MNA	690
ASM	472
BLM	681
Prescott College	23
USFS	713
NPS-Grand Canyon	17
NPS-LMNRA	1

The proper interpretation of Table 7 is that excluding the Grand Canyon, most work on the Arizona Strip has been conducted by either the BLM, the Forest Service, or MNA (most of which was performed under contract to the BLM). A substantial amount of work has also been conducted by the NPS in the Lake Mead National Recreation Area.

These conclusions can also be viewed graphically as shown in Figures 51, 52, and 53. These figures plot the information for the variable "owner agency" for AZSITE, whereas the location of all sites in the Forest Service files are shown as "owned" by the Forest Service. The figures, although accurate as far as the databases are concerned, need some clarification. Figure 53 which plots sites "owned" by agencies other than the BLM or the Forest Service, basically displays (1) sites located in the Lake Mead National Recreation Area and (2) sites recorded by MNA on the Paria Plateau (in the northeast part of the Strip) and on Mount Trumbull. The sites recorded by MNA are not "owned" by MNA; rather they are all located on BLM land and administered by that agency. Similarly, all sites located in the Kaibab National Forest are administered by the Forest Service. Site locations in the Forest (shown in Figures 53 and 54), that indicate that agencies and institutions other than the Forest Service "own" sites in the North Ranger District of the Kaibab National Forest clearly represent coding errors. Finally, the heavy concentration of sites in the Big Springs study window in Figure 51 is misleading. For several years Universal Transverse Mercator (UTM) numbers were not calculated for sites recorded on the North Kaibab Ranger District. The net result on the North Kaibab Ranger District is that of the 713 sites recorded, 539 (75.6%) lack UTMs. To conduct the modeling exercise described in Chapter 9, we digitized all site locations in the Big Springs area. Thus, this area appears to contain the heaviest concentration of sites on the North Kaibab Ranger District. This is not necessarily the case, however, and until all site locations have UTMs, we cannot even determine the exact distribution of known sites on the Forest.

The pattern of site location presented in Figures 51 through 53 should not be taken as representative of areas of site concentration or site absence on the Arizona Strip. Instead, these figures more-or-less display where surveys have been conducted. In particular, areas of high concentration correspond to the intensive surveys of the Paria Plateau, Mount Trumbull, and portions of Lake Mead. The area around the Virgin River also has a fairly high site density, which reflects the long history of archaeological interest in the region.

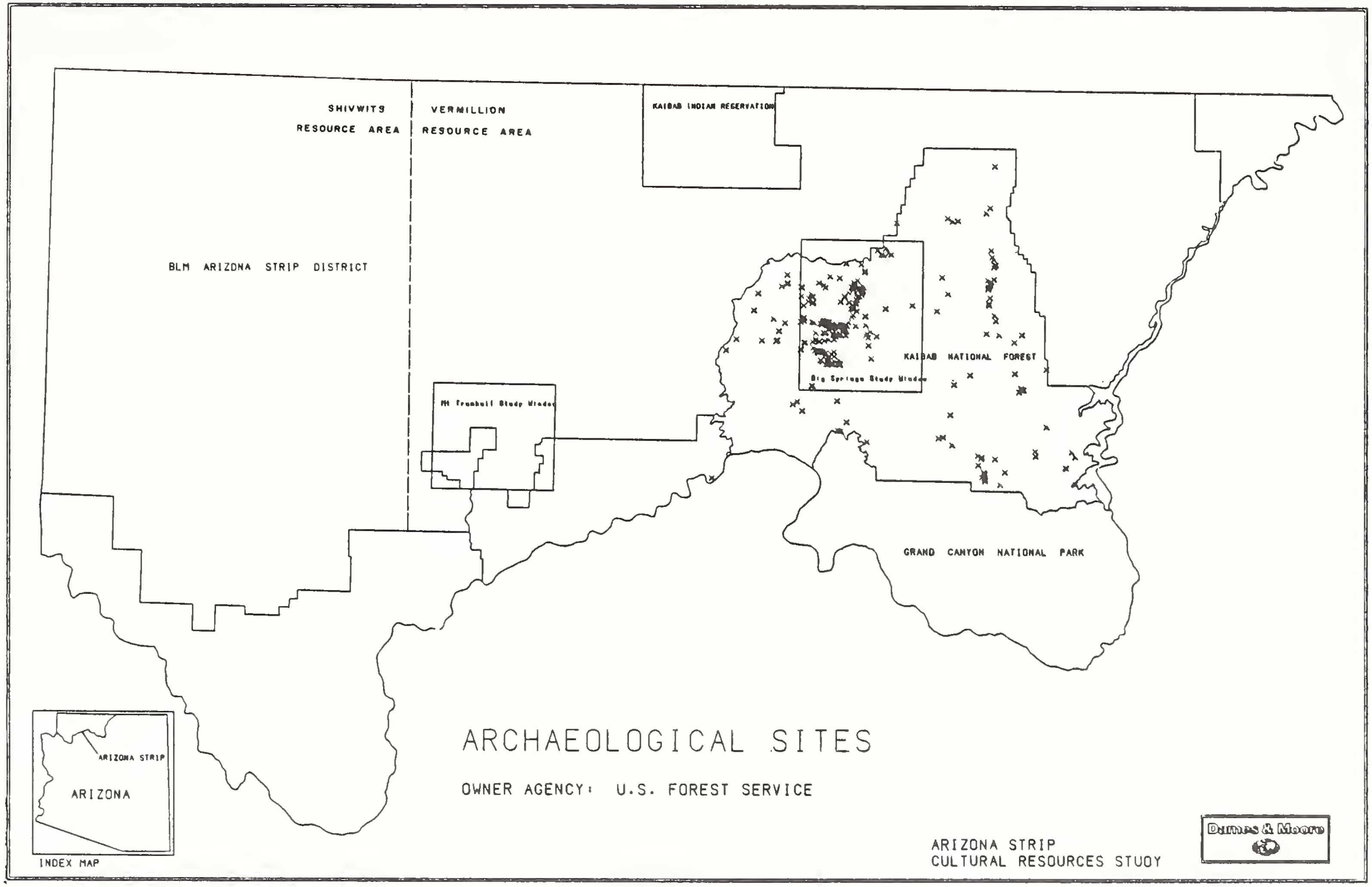


Figure 51. USFS Components.

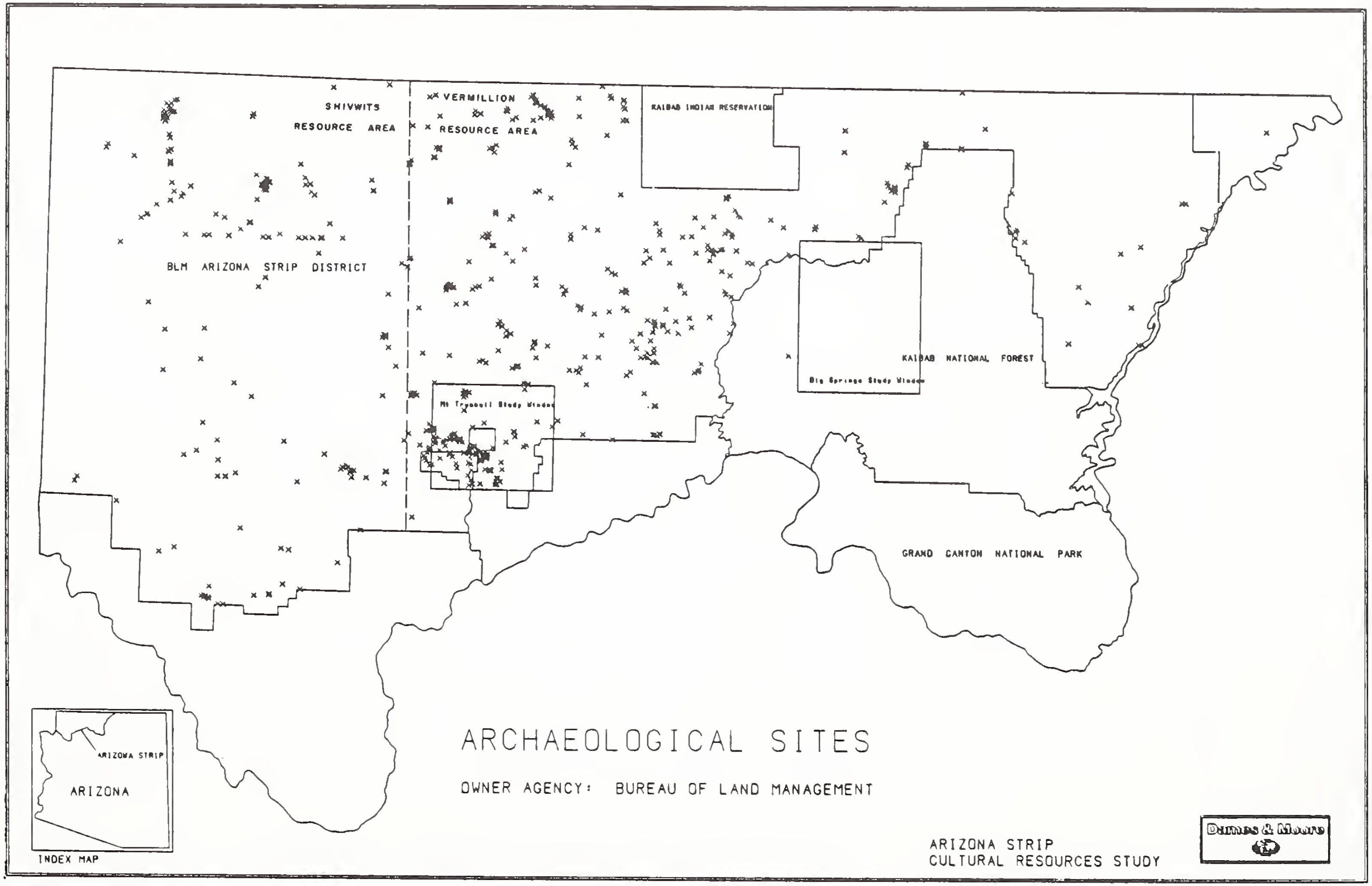


Figure 52. BLM Components.

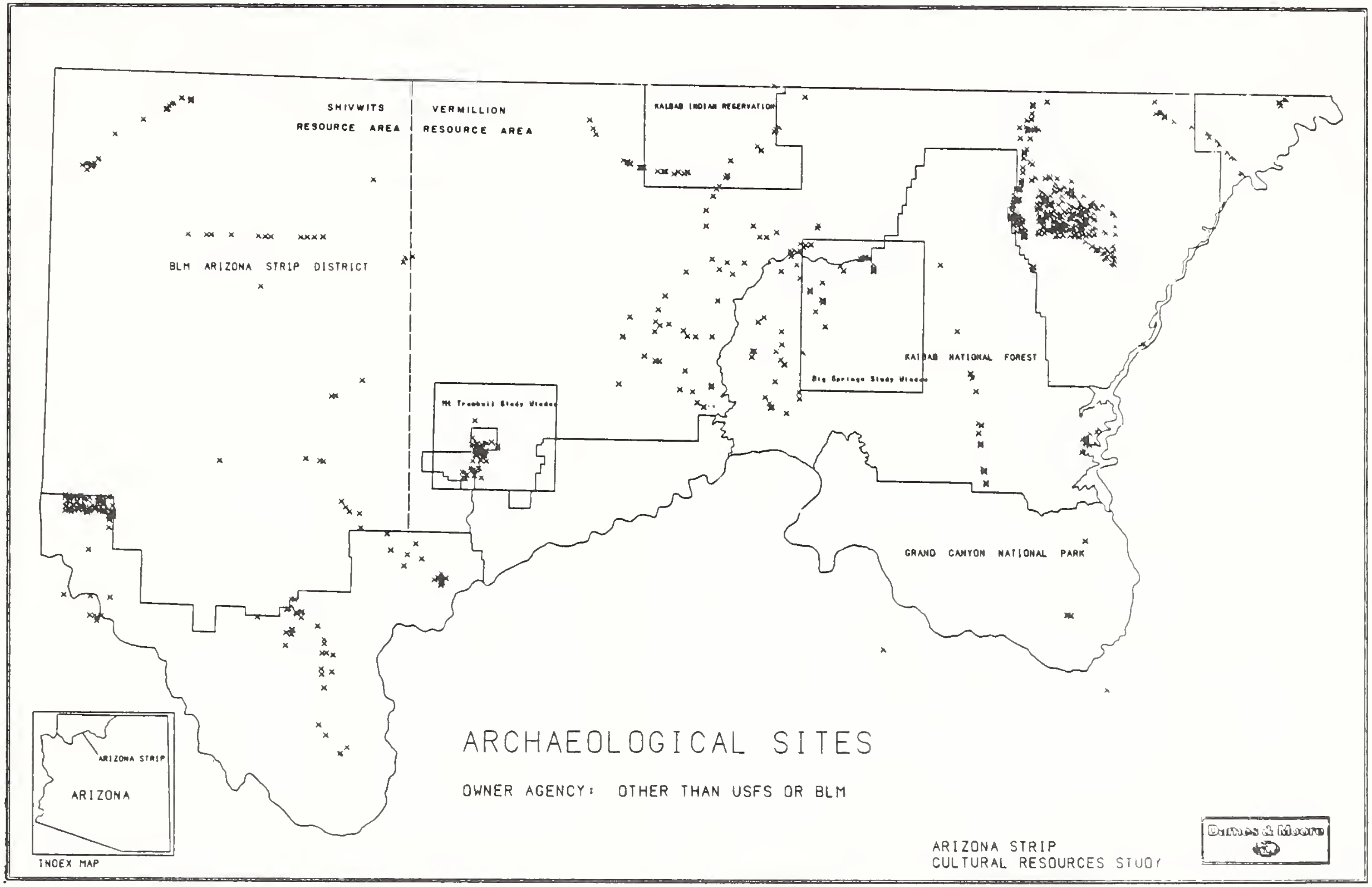


Figure 53. Components of Other Agencies and Institutions.

For prehistoric sites, limited activity and habitation components are equally well represented on the Arizona Strip (Table 8), with both constituting just over 43 percent of the total number of components. Base and temporary camps account for 12.4 percent of the total, while sites of unknown site type make up less than 1 percent of all components recorded. These percentages are reflected in Figures 54, 55, and 56. Habitation sites are concentrated on the Paria Plateau, Big Springs area, and Mount Trumbull. Base and temporary camps follow a similar pattern, although there is also a cluster of these types of sites in the Virgin River drainage. Limited Activity sites are more evenly spread out over the Arizona Strip. There is one notable concentration of lithic scatters and quarry sites in the northwest corner of the Lake Mead Recreational Area.

The Formative is by far the best represented time period on the Arizona Strip. Nearly 64 percent of all components date to the Formative Period. This figure reaches over 92 percent of components that can be dated (i.e., all codes in Table 9 except 19 and 99). The Archaic and Neo-Archaic periods are poorly represented on the Arizona Strip, each accounting for about 2.5 percent of all components. There are no strong distributional patterns to these data (Figures 57, 58, 59, and 60). It is of some interest to note that Archaic period components are absent from the Paria Plateau, and only one such component has been found in the Mount Trumbull area. Formative period components are found all over the region, but Neo-Archaic components, most of which are associated with Paiute occupations, are more prevalent in the western portion of the Arizona Strip.

Finally, the data for prehistoric sites on the Arizona Strip are cross-tabulated by time period and site type for each administrative unit in Tables 10, 11, and 12. These tables suggest that sites in the eastern part of the Arizona Strip arelargely habitation components dated to the Formative period (47 percent for the Vermilion Resource Area and 57 percent for the Forest Service). Less than 30 percent of the Forest Service components and only about 42 percent of the Vermillion Resource Area components represent limited activity occupations. In contrast, data from the Shivwits Resource Area indicate that undiagnostic artifact scatters are the most prevalent site type encountered here. This pattern holds for the entire western Arizona Strip. In fact, the trend noted in Table 11 would be even stronger if data from the Lake Mead National Recreation Area (which, of course, is not part of the BLM Shivwits Resource Area) were added.

Historic components presently recorded on the Arizona Strip largely fall into two categories; habitation and industrial/economic (Table 13). On the North Kaibab Ranger District of the Kaibab National Forest most of the habitation sites are isolated rock or log cabins. Industrial components are evenly divided between mining and lumbering activities, with only a few recorded components associated with either ranching or farming. Historic components listed on AZSITE are heavily weighted toward industrial/economic activities. Much like the North Kaibab Ranger District, most components in this category are affiliated with mining and lumbering. In addition, a relatively large number of ranching components are listed. These take the form of corrals, fencelines, sheepherder camps, and ranches.

Habitation components are the second most frequent site type encountered on AZSITE. Dugouts and cabins are the two habitation sites that are listed most often. The third most frequent historical site category on AZSITE is rock art/survey markers. Most of the rock art is recorded as "Mormon" affiliated, although the exact nature of these sites cannot be determined from the site forms. Finally, trash disposal sites are poorly represented throughout the Arizona Strip. It is worth noting, however, that many habitation components are also listed as having trash deposits.

Table 8. Prehistoric Components by Site Type Taken From AZSITE and USFS CRM Databases (See Appendix 2 for a full description of site types).

Site Type	Code	Number	Percent
Habitation Sites			
Non-Cont. rooms, no room count	3	6	0.2
Pueblo/Non-Cont, no room count	5	22	0.8
Pueblo/Non-Cont, 5 or less room	6	100	3.7
Pueblo/Non-Cont, 6-15 rooms	7	60	2.2
Pueblo/Non-Cont, 15+ rooms	8	22	0.8
Pueblo/roomblock, no room count	9	117	4.4
Habitation site, type unknown	10	32	1.2
Large struct. site, 15+ rooms	11	6	0.2
Medium struct. site, 6-15 rooms	12	10	0.4
Small struct. site, 2-5 rooms	13	77	2.9
Large Pueblo, 15+ rooms	14	41	1.5
Medium Pueblo, 6-15 rooms	15	125	4.7
Small Pueblo, 2-5 rooms	16	258	9.6
Isolated structure, 1 room	17	300	11.2
Total -- Habitation		1,176	43.8
Campsites			
Base Camp	18	122	4.5
Base or Temp. Camp	19	79	2.9
Temporary Camp	20	135	5.0
Total -- Campsites		336	12.4
Limited Activity Sites			
Limt. Act. Site, type unknown	30	3	0.1
Quarry/Mine	31	127	4.7
Lithic scatter	32	596	22.3
Sherd scatter	33	38	1.4
Lithic and sherd scatter	34	299	11.1
Isolated roasting pit	35	9	0.3
Isolated hearth	36	1	0.0
Isolated rock art	37	37	1.4
Isolated granary/cist	38	32	1.2
Agricultural feature	39	10	0.4
Trail	40	2	0.1
Burial	41	0	0.0
Other Limt. Act. Site	49	3	0.1
Total -- Limited Activity Sites		1,157	43.1
Site Type Unknown	99	18	0.7
Total		2,687	100.0

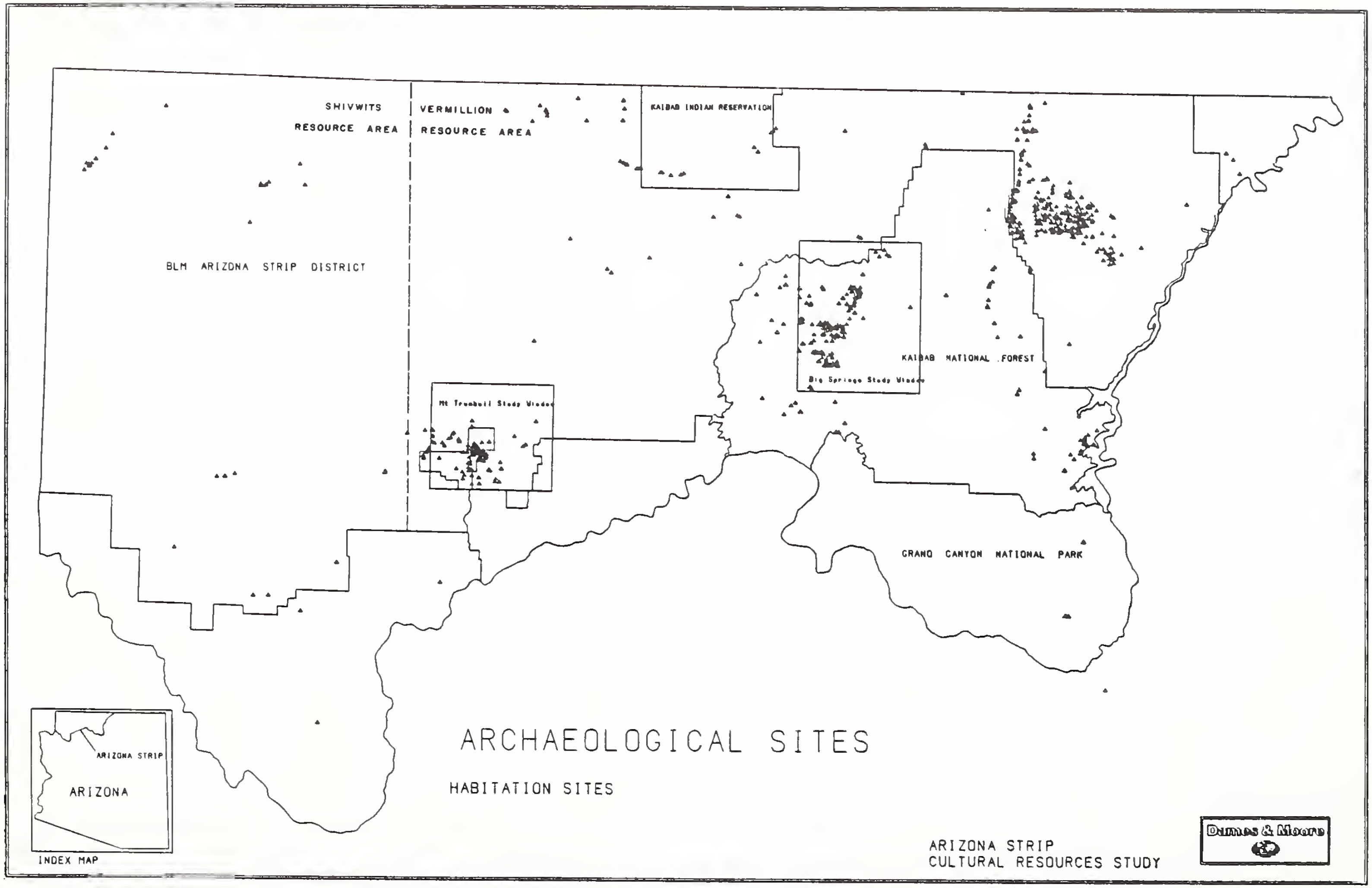


Figure 54. Habitation Components.

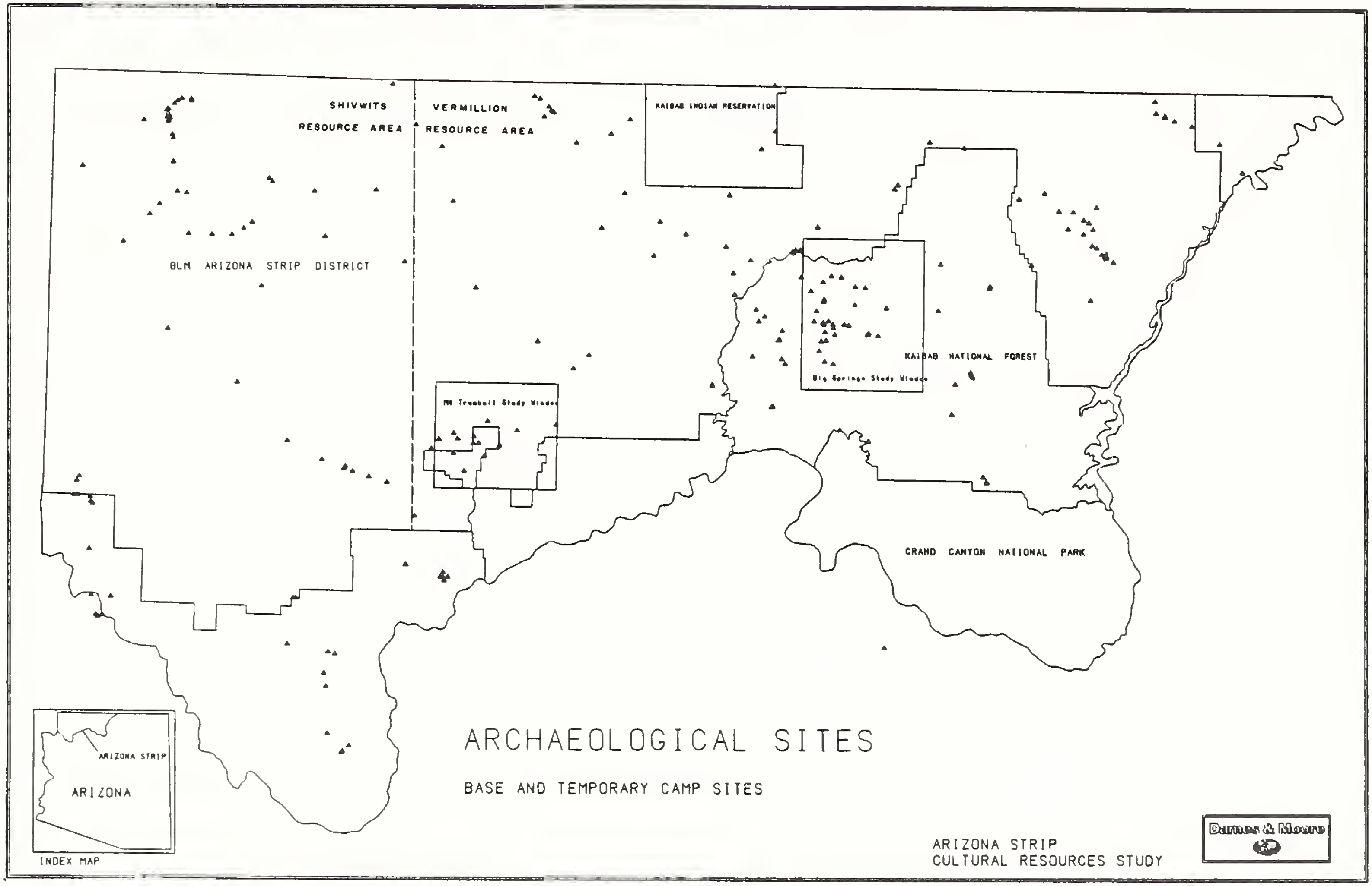


Figure 55. Base and Temporary Camp Components.

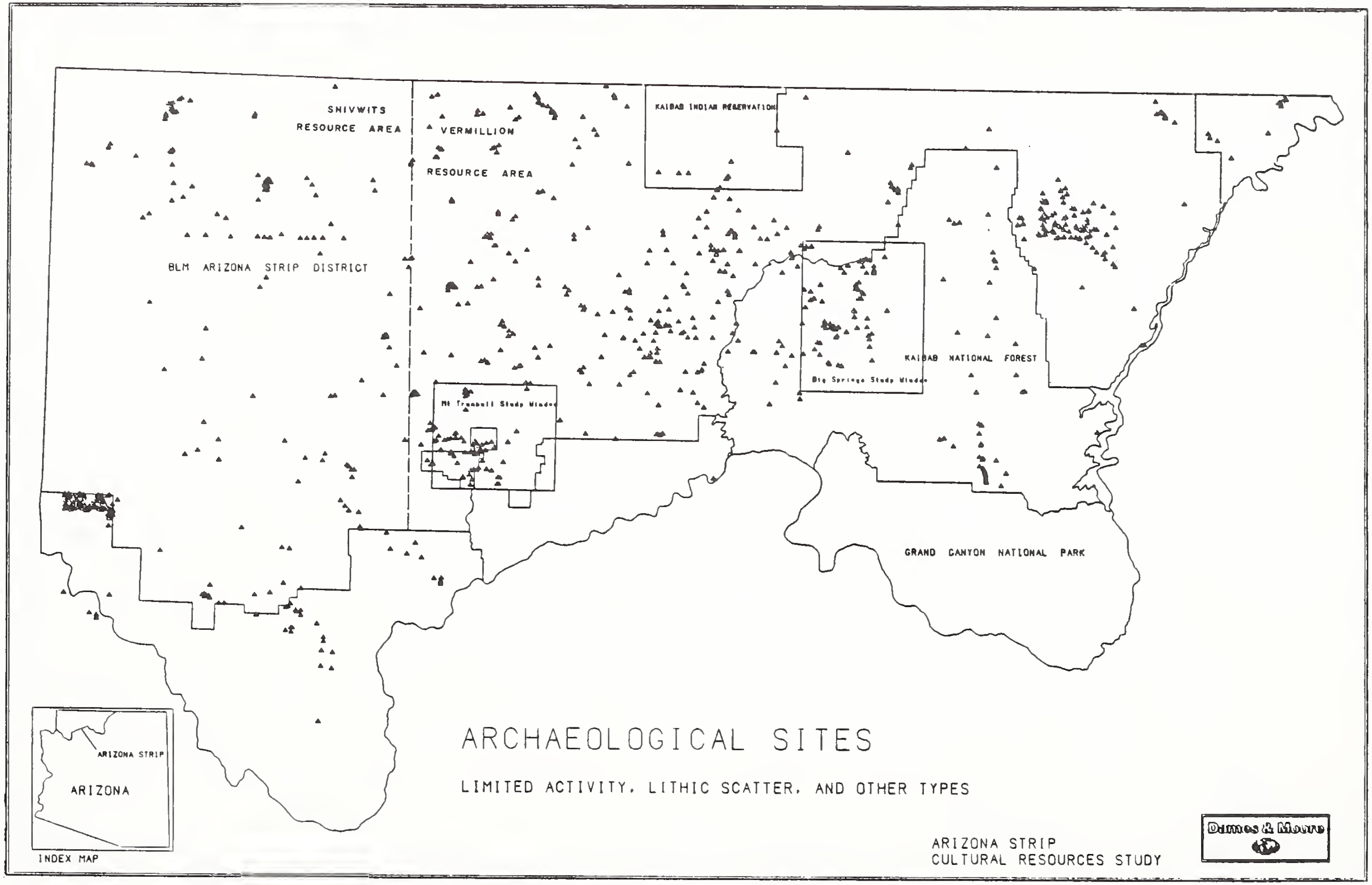


Figure 56. Limited Activity and Other Site Type Components.

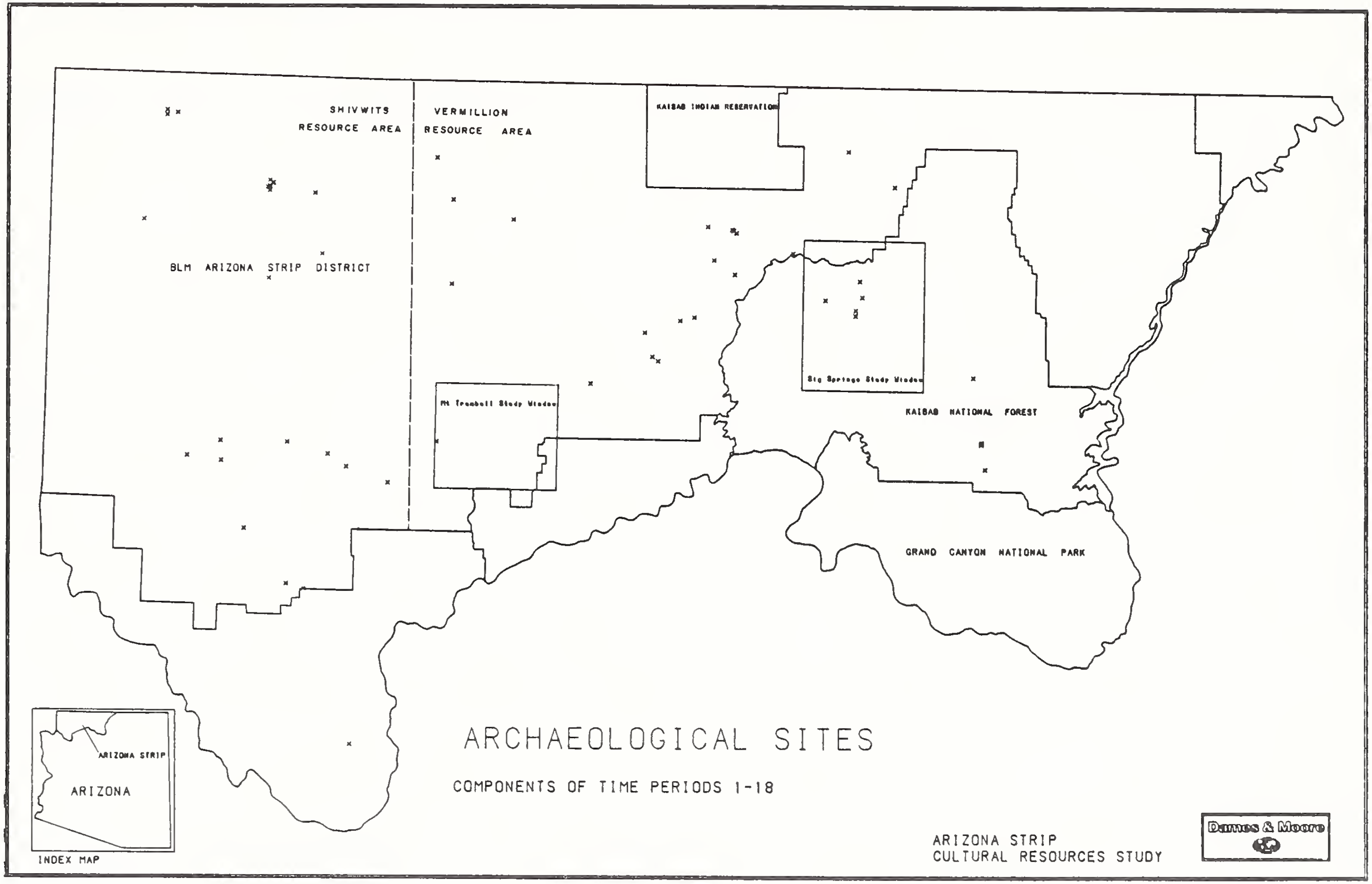


Figure 57. Paleoindian and Archaic Period Components.

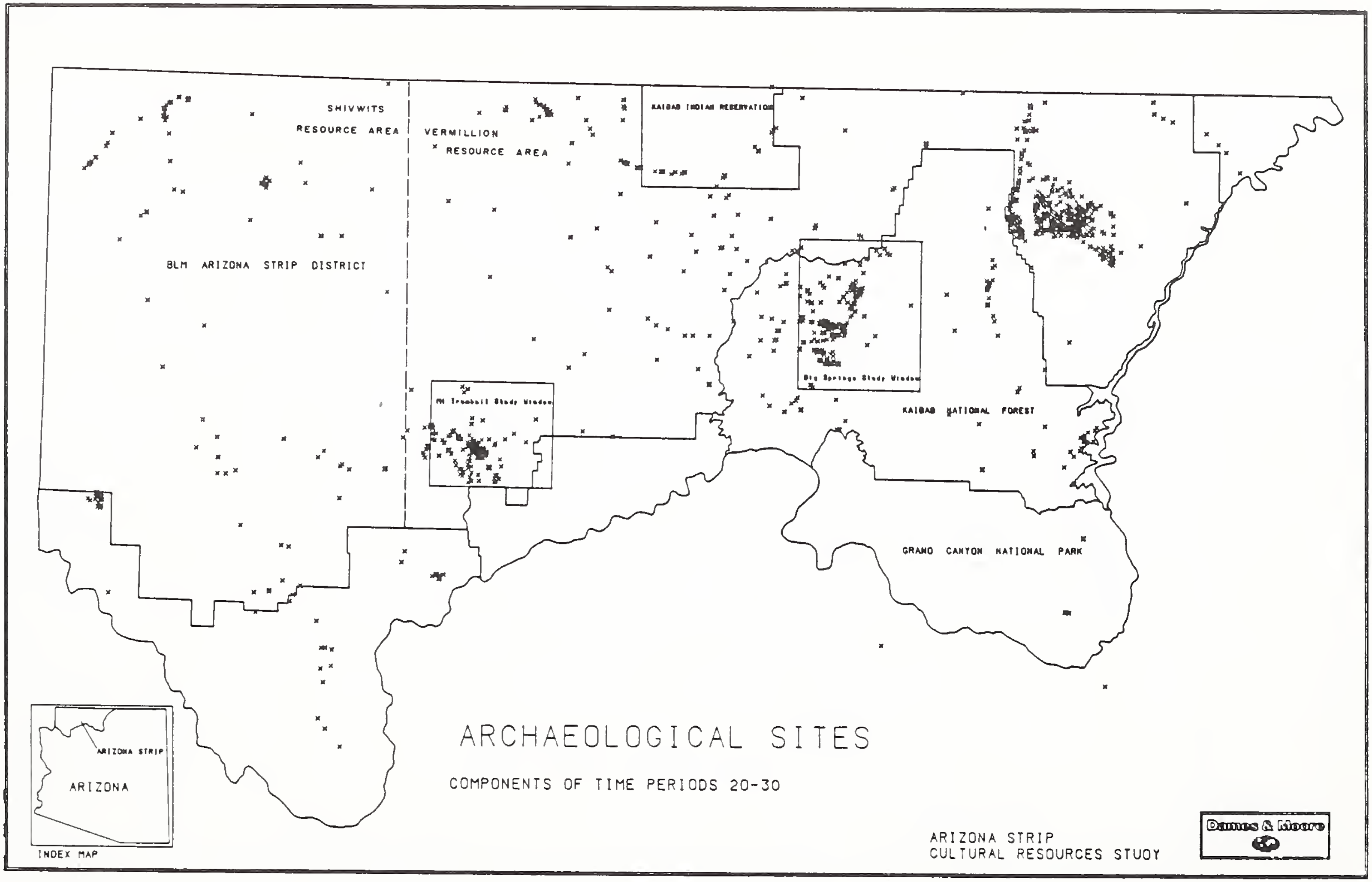


Figure 58. Formative Period Components.

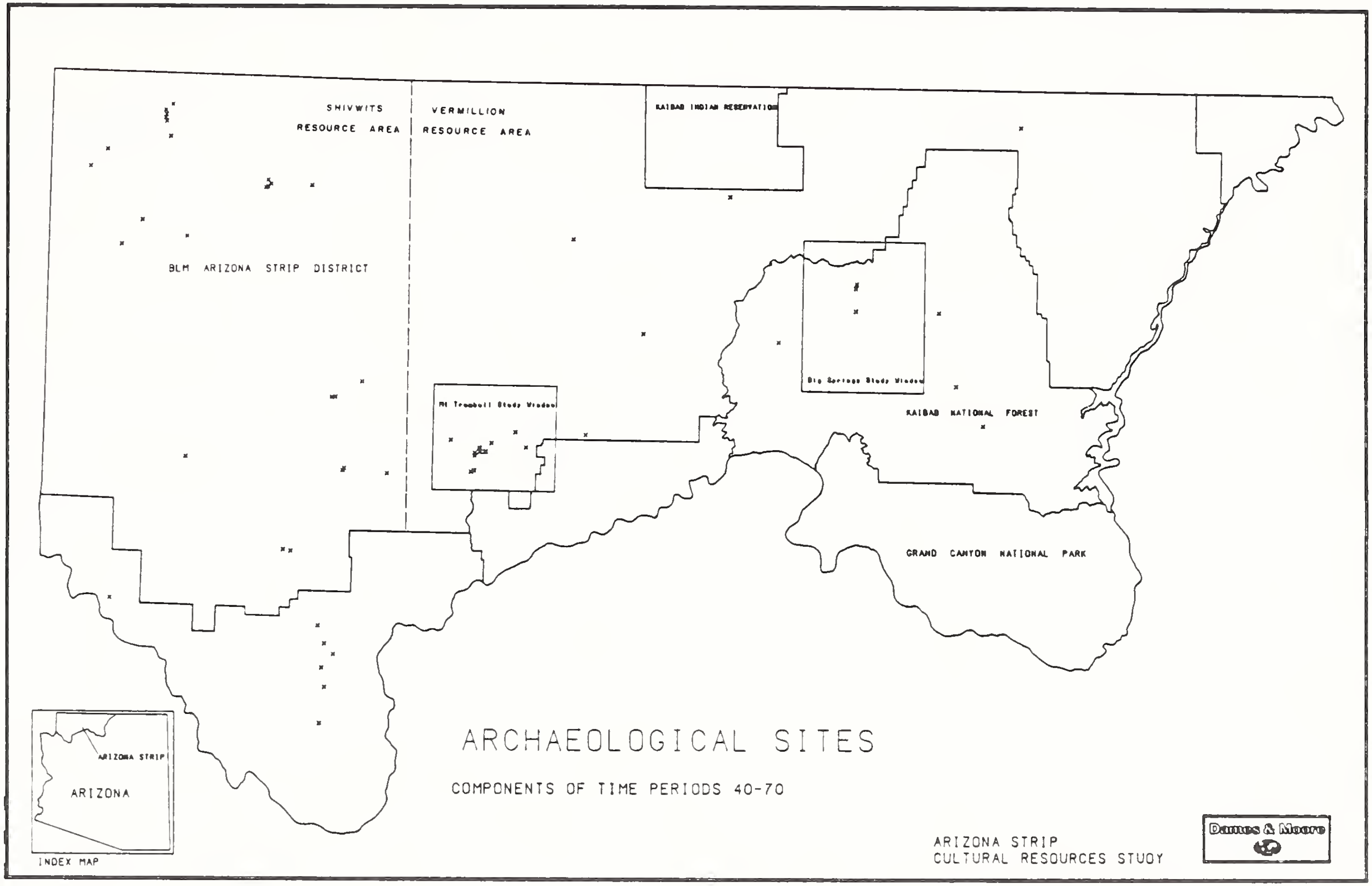


Figure 59. Neo-Archaic Period Components.

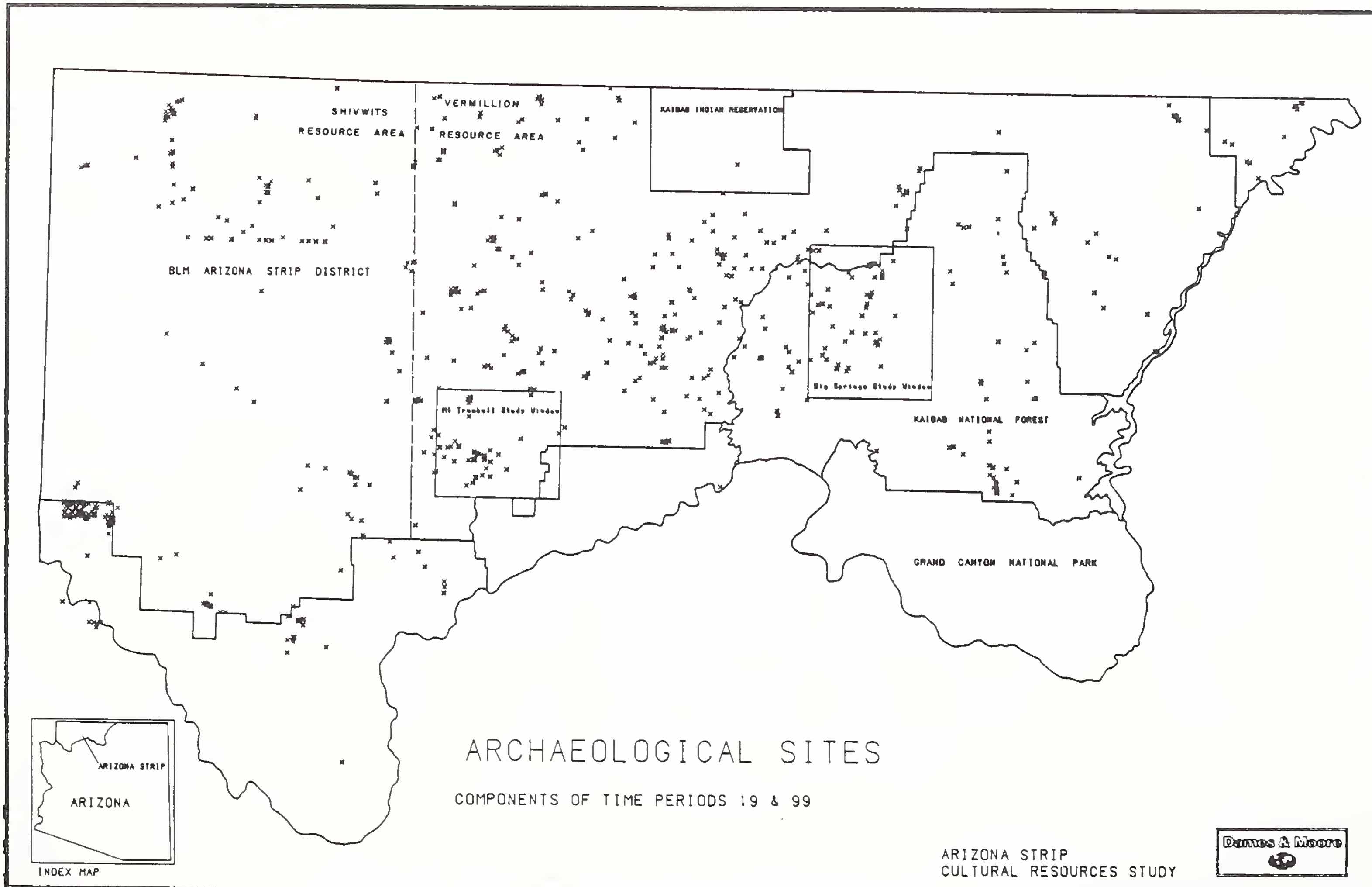


Figure 60. Undated Site Components.

Table 9. Components by Time Period, Taken From AZSITE and USFS CRM Databases.

Time Period	Code	Number	Percent
Paleo Indian	1	1	0.0
Archaic	10	54	2.0
Early Archaic	11	3	0.1
Middle Archaic	13	0	0.0
Late Archaic	15	3	0.1
Late Archaic/BMII	18	8	0.3
Aceramic/Unknown	19	17	0.6
Pueblo/Anasazi	20	460	17.1
BMIII	21	10	0.4
BMIII-PI	22	32	1.2
Early PII	23	14	0.5
Early Anasazi (BMIII-Early PII)	24	104	3.9
Mid PII	25	108	4.0
Late PII	26	251	9.3
Early PIII	27	48	1.8
Late Anasazi (PII-Early PIII)	28	215	8.0
Late PIII	29	17	0.6
PII	30	451	16.8
PIV-V Hopi?	40	2	0.1
Prehistoric Paiute	50	63	2.3
Historic Paiute	51	2	0.1
Historic Navajo	60	2	0.1
Historic Paiute/Navajo	70	0	0.0
Unknown	99	822	30.6
	Total	2687	99.9

Table 10. Site Type by Time Period, USFS.

Site Type	Time Period					
	Archaic/ Paleo-Indian	Formative	Neo-Archaic	Unknown	Total	Percent
Habitation	0	207	0	6	213	59.3
Base and Temporary Camp	0	28	3	9	40	11.2
Limited Activity	4	28	2	65	99	27.6
Unknown	0	4	1	2	7	1.9
Total	4	267	6	82	359	100.0
Percent	1.1	74.4	1.7	22.8	100.0	

Table 11. Site Type by Time Period, BLM Shivwits Resource Area.

Site Type	Time Period					
	Archaic/ Paleo-Indian	Form-ative	Neo-Archaic	Unknown	Total	Percent
Habitation	0	29	2	4	35	7.8
Base and Temporary Camp	6	41	13	33	103	20.7
Limited Activity	20	68	17	211	316	70.4
Unknown	0	1	2	2	5	1.1
Total	26	139	34	250	449	100.0
Percent	5.8	30.9	7.6	55.7	100.0	

Table 12. Site Type by Time Period, BLM Vermilion Resource Area.

Site Type	Time Period					
	Archaic/ Paleo-Indian	Form-ative	Neo-Archaic	Unknown	Total	Percent
Habitation	0	646	4	16	666	48.7
Base and Temporary Camps	4	79	2	36	121	8.9
Limited Activity	23	211	11	331	576	42.1
Unknown	0	0	2	2	4	0.3
Total	27	936	19	385	1367	100.0
Percent	2.0	68.5	1.4	28.1	100.0	

Table 13. Historic Components.

	Site Class					
	Habit-ation	Indust/ Economic	Rock Art/ Markers	Trash Disposal	Unknown	Total
Database						
USFS	23	22	4	3	1	53
AZSITE	32	60	13	5	0	110
Total	55	82	17	8	1	163

SITE CONDITION AND STATUS

Both the Forest Service and the BLM evaluate sites in terms of their potential eligibility for inclusion in the National Register of Historic Places. In addition, the Forest Service has started to classify sites into management "use" categories, and the BLM will also begin doing so shortly. These site evaluations are summarized in Table 14.

Table 14. Site Evaluation, AZSITE and USFS.

AZSITE

National Register Status	Number	Percentage
Eligible	446	20.3
Listed District	0	0
Listed Individual	0	0
Not Eligible	0	0
Probably Eligible	209	9.5
Probably Not Eligible	764	34.7
Unknown	758	34.5
Missing or Invalid Ans.	23	1.0

State Register Status		
Eligible	24	1.1
Listed District	0	0
Listed Individual	0	0
Not Eligible	0	0
Probably Eligible	211	9.6
Probably Not Eligible	724	32.9
Unknown	334	15.2
Missing or Invalid Ans.	907	41.2

USFS

On National or State Reg	3	0.4
Unevaluated	618	77.5
Unevaluated-has potential for Management Consideration	68	8.5
Removed from Management Consideration	9	1.1
Display (Site Museum)	1	0.1
Scientific Study	2	0.3
Combination of Use	49	6.1
Blank	47	5.9

Of the 2,200 sites coded on AZSITE for the Arizona Strip, a little less than a third are listed as eligible or potentially eligible for the National Register, a third are considered ineligible, and just over a third have not been evaluated. For the State Register, about 10 percent are coded as eligible, about 33 percent are recorded as ineligible, and the bulk of the sites (over 55%) have not been evaluated.

The situation on the North Kaibab Ranger District is somewhat different. Of the 797 sites coded for the site evaluation variable, 618 (77.5%) are coded "unevaluated," 49 (5.9%) have been left blank, and 68 (8.5%) are coded "unevaluated--has potential for assignment." Thus, nearly 92 percent of all sites on the North Kaibab Ranger District have not received formal evaluations. This situation does not reflect a difference in practice as much as a difference in coding between the Forest Service CRM database and AZSITE. Most of the unevaluated sites on the North Kaibab Ranger District would be coded "probably eligible," if such a code existed (John Hanson, personal communication, 1988). Of the 64 sites on the North Kaibab Ranger District that have been evaluated, 49 are considered candidates for a variety of uses, while 9 have been removed from management consideration (i.e., are not eligible for either the State or National Register). Four sites on the North Kaibab Ranger District are currently listed on the State and/or National Registers of Historic Places, and two sites have been formally designated as candidates for scientific study.

Site conditions are difficult to compare between resources administered by the BLM and those administered by the Forest Service due largely to differences in recording and coding (Table 15). AZSITE data indicate that over half the sites on the Arizona Strip are undisturbed, 30 percent are destroyed or disturbed, and no data are available on the rest. Natural erosion is by far the greatest source of disturbance, accounting for over 40 percent of all disturbed sites. Grazing is the second most prevalent cause of disturbance, followed, in descending order, by vandalism, construction, and range improvement. About 25 percent of the sites listed on AZSITE for the Arizona Strip have been surface collected, while only 10 sites have been excavated and three sites tested. Collections are listed as available for less than half of the sites that are purported to be surface collected (247 out of 561), and for only three of the ten excavated sites.

Sites on the North Kaibab Ranger District fall into two major site condition categories: undisturbed and artificial impact. Most of the sites are coded as 'artificial impact,' which is a catch-all groups used when specific sources of site deterioration cannot be identified. Between 40 and 45 percent of the sites on the North Kaibab Ranger District have been disturbed (the exact percentage cannot be determined because there is a difference in the number of sites coded "undisturbed" and "0 percent disturbed" in the Forest Service CRM database), although most of these (around 75 percent) have suffered only minor disturbances (20 percent or less of the total site has been disturbed).

SUMMARY

This chapter has highlighted two themes. The first concerns the difficulty of utilizing large computerized databases. Different systems must be linked, and the quality of the data must be assessed. Beyond mechanical problems, there are more intractable ones. How do we determine if the data are representative of site locations by time period and site type? If the data are skewed, how do we interpret the results? Questions of the type listed above are common to all regional studies that use data collected by different people, under different conditions, and at different times.

Table 15. Site Condition, AZSITE and USFS.

AZSITE

Site Condition	Number	%
Destroyed	65	3.0
Disturbed	445	20.3
Intruded	1	0
Partially Destroyed	153	7.0
Undisturbed	1142	51.9
Unknown	215	9.8
Missing or Invalid Ans.	179	8.1
Source of Disturbance		
Fire	7	1.3
Flood	0	0
Grazing	76	14.0
Mining	4	0.7
Off Road	5	0.9
Range Improvements	42	7.7
Timbering	9	1.7
Vandalism	69	12.7
Erosion	223	41.0
Construction	65	11.9
Unknown	44	8.1
Missing or Invalid Ans.	0	0
Archaeological Investigation Status		
Collected	561	25.5
Excavated	10	0.4
Tested	3	0.1
Undisturbed	787	35.8
Unknown	545	24.8
Missing or Invalid Ans.	294	13.4
Collections		
Excavated	3	0.3
None	668	72.8
Stratigraphic	0	0
Surface	247	26.9

USFS

Site Condition	Number	%
Eroded	72	9.0
Undisturbed	315	39.3
Pothunted	7	0.9
Artificial Impact (AI)	303	37.8
Eroded and AI	24	3.0
Pothunted and AI	11	1.4
Eroded, Pot-hunted, and AI	3	0.4
Excavated	0	0
Collected	10	1.2
Tested	0	0
Inundated	0	0
Animal Impact	10	1.2
Grazed	10	1.2
Site Prep Damage	0	0
Revegetation Dam.	0	0
Timber Damage	1	0.1
Blank	24	3.4
Percent Disturbance	**Number**	**%**
0	354	44.1
>0 - 5	104	13.0
>5 - 10	70	8.7
>10 - 20	77	9.6
>20 - 50	103	12.8
>50 - 80	68	8.5
>80 - 100	26	3.2

The problems associated with using large databases are often compensated for by their power. With relative ease we can display the locations of all sites recorded on BLM and Forest Service land within the Arizona Strip. This ability leads to the second theme of the chapter, the general patterns of site distribution and site condition on the Arizona Strip. Although the data clearly contain a certain number of errors in coding and recording, there is little doubt that the general patterns that are illustrated in the figures of this chapter accurately reflect the current database. This chapter should be viewed, therefore, as a baseline both of what is currently being recorded and what is not.

CHAPTER 8

THE STRUCTURE OF CULTURAL RESOURCE MANAGEMENT PROGRAMS ON THE ARIZONA STRIP

Jeffrey H. Altschul

Cultural resources, especially prehistoric cultural resources, are unlike all other resources that the BLM and the Forest Service manage. In contrast to timber or water resources, in which the location, amount, and potential impacts of various development proposals can be readily assessed, cultural resources are noted more for what we cannot determine than for what we can. As the previous chapters have indicated, our knowledge about where cultural resources are located is based on the idiosyncratic interests of individual researchers and, especially within the last two decades, the vagaries of resource development. The database has been biased not only by where people have looked for sites, but also by the variable way sites have been recorded. Thus, although about 4,000 components have been recorded on the Arizona Strip, we still cannot state confidently where sites are likely to be found and where they are probably absent. Further, as demonstrated in Chapter 6, the primary issues being addressed on the Arizona Strip are basic questions of chronology and cultural affiliation. Our ability to move beyond basic issues of time and space is not constrained by the size of the database but rather by the fact that we can rarely date the sites below the level of culture (i.e., Archaic, Anasazi, etc.) and because the survey universes have boundaries that bear no relation to cultural boundaries. In terms of significance evaluation, then, at this time we rarely can conclude that a site does not have the potential to provide important information on the prehistory of the area. This assessment is not necessarily because of any intrinsic feature or peculiarity of a site, but simply because we are not in a position to judge which data are important to examining the prehistoric development of the Arizona Strip, and which are redundant.

From a management perspective, this situation presents a serious problem. Each time a land development project is proposed, an ad hoc archaeological survey must be performed. The archaeologist evaluates the results and recommends what, if any, additional work must be undertaken. Sometimes it is necessary to test the sites to determine their potential eligibility for inclusion in the National Register of Historic Places. For significant sites (i.e., sites deemed eligible for the National Register) there are basically two management options. The first is to avoid them. The second is to mitigate the impacts to these resources through some form of data recovery.

On the Arizona Strip, CRM procedures have evolved into one basic strategy for federal projects (e.g., timber sales, roads, or fence lines). A project is proposed, an archaeological survey conducted, and the project is redesigned to avoid all cultural resources. The major exceptions to this "rule" are private developers who fund cultural resource management with their own money.

The "avoidance" approach is attractive to management for two basic reasons; time and money. Archaeological excavation, even at the testing level, requires more labor and more money per resource than survey. On the Kaibab National Forest, archaeologists survey approximately 15,000 acres annually. The surveys and their attendant reports are basically all the present archaeological staff can accomplish. To test even a small number of the more than 100 sites recorded every year would require greatly expanding the cultural resource staff and its funding level. It is simply far easier for the Forest Service to adopt an approach in which every site, whether upon testing it would be determined significant or not, is avoided by either moving a road or just marking an area within a timber sale for avoidance.

The approach is certainly less costly, but is it in the best interest of the agency or the public at large? Regardless of its economic impact, avoiding resources puts the BLM and the Forest Service in a reactive, as opposed to active posture, in regards to cultural resource management. Whether intended or not, the BLM and the Forest Service on the Arizona Strip have followed a policy that interprets the agency's responsibility toward cultural resources as one of preserve and protect. By following this policy the BLM and the Forest Service have been remarkably successful in locating and avoiding hundreds of cultural resources each year. They have been less successful in translating their field results into substantive advances. For example, in the past two decades the number of sites recorded on the Arizona Strip has more than doubled, yet our understanding of the past has not. In comparing past overviews of the Strip (Lipe and Thompson 1979) with the present one, it is clear that we are still struggling with the same basic research issues and that our knowledge of prehistory has not advanced significantly. Although there are many reasons for this situation, the attitude and policies of the major land holding agencies in the past have been a major contributing factor. By following a strategy in which resources were located on a map, but not enough work was done to determine much more than their temporal or functional placement, the agencies contributed to a situation that benefited neither management, archaeology, nor the resources.

Part of the reason the Forest Service and the BLM have adopted such a strict avoidance approach is the difficulty in assessing the potential significance of a site from surface observations. There are some cases in which a site's significance is relatively clear. For example, most archaeologists working on the Strip would agree that an undisturbed stratified rock shelter site would be eligible for the National Register. Likewise, many archaeologists would agree that a site consisting of a small number of dispersed flakes would not be eligible for the National Register. The problem, of course, is the vast majority of sites in between these extremes. In these cases, archaeologists are rightfully reticent to determine eligibility in the absence of subsurface tests.

The situation has deteriorated into a vicious cycle on federally administered lands on the Strip. Each year more sites are recorded. Without detailed surface examination or subsurface testing, federal archaeologists cannot generally determine the temporal or functional attributes of these sites. As the number of "gray" sites (i.e., those that are located, but not assessed) grows, it becomes increasingly difficult to address regional research issues because we cannot define meaningful site types and thus we are unable to study the distribution of sites of the same type or the relations between different site types. As the numbers of recorded sites increase, these problems become more and more intractable. It becomes simpler not only for the agency concerned with cost, but also for the federal archaeologists who are not sure which resources will provide the most insight into the past to simply "protect" all resources until a time when the database can be assessed and direction for research selected.

To a certain extent overviews such as this are designed to provide that direction. The previous four joint BLM/Forest Service cultural resources overviews for Arizona have all stressed the need for additional survey. They have taken as one of their primary objectives the design of Class II sample surveys. To a large extent the emphasis on sample surveys derives from the basic federal tripartite approach to CRM, which views a primary function of a Class I overview to be the establishment of guidelines for Class II sample surveys. Although this approach may have worked in certain areas in the past, such as during the late 1970s when the BLM was able to fund substantial numbers of Class II sample surveys in areas of mineral exploration, the process has not worked well in most parts of Arizona in general or in the Strip in particular. As originally conceived, Class II surveys were designed to be part of the planning process. Most were designed as probabilistic sample surveys, thereby allowing the results to be generalized from the relatively small amount of surveyed area to much larger regions.

Although a number of Class II sample surveys have been conducted by the Park Service along the southern edge of the Strip, the only major Class II sample survey conducted on BLM or Forest Service lands on the Strip has been the Mount Trumbull survey (Moffitt and Chang 1978). Further, it is a fair statement that neither the Forest Service nor the BLM foresees using Class II sample surveys for planning purposes on the Strip in the immediate future. The archaeological staffs of both agencies work nearly full-time on Class III compliance surveys. To conduct "planning" surveys would require substantial increases in staff and funding of both agencies.

Given this situation, producing guidelines for Class II surveys seems to be an unproductive exercise at best. What then do the agencies need? To our mind, both the Forest Service and the BLM need to shift their CRM programs to a more active posture. One means of accomplishing this goal is through specific CRM plans. Both agencies are pursuing this course, and our suggestions relate only to the orientation to parts of the plans. In short, part of these plans should specify what to do when cultural resources are to be adversely impacted by the development or enhancement of other resources (e.g., avoidance, mitigation). Other parts of the plan should describe the courses that are to be undertaken to enhance and interpret the cultural record.

To date the Forest Service and the BLM have followed the first part of the prescription on the Strip as though it were <u>the</u> CRM plan. This path has resulted in an immense database, but little gain in knowledge. How can we change this situation within the present staffing and funding levels? The first step in this process is to comprehend what is already known; that is, to compile the existing database. This overview goes a long way in that direction. Forest Service and BLM cultural resource data have been standardized by component, and displayed and tabularized across the Strip. It is worth pointing out that the next logical step in this process would be to continue this process for the nearly 1,200 sites recorded on the north side of the Grand Canyon within the National Park boundaries. Unfortunately, such a step was beyond the scope of the present project.

Once the data are compiled, they must be evaluated. At present, the most serious problem hampering our understanding of Arizona Strip prehistory is the variable quality of the data. This problem goes far beyond issues of comparability in which one investigator legitimately views a phenomenon differently than another, or even consistency in which an investigator refers to the same or similar phenomena differently on separate occasions. These are certainly serious problems, but they can be overcome as long as accurate data on each site are recorded. For example, on this project we had two people recode all sites on AZSITE and the Forest Service CRM database by component for a number of attributes (see Chapter 7). Although by no means a simple task, we found that as long as the information was available on the original site record, we had little problem classifying components into the types we defined, regardless of what the original investigators termed them. Although we make no presumption that our categories are "correct" in any theoretical sense, we are confident that they have been consistently applied.

At the outset we had trepidations about our ability to utilize the databases to address serious research concerns. We found, however, that our biggest problem was not in evaluating data, but rather in dealing with the fact that so much data were simply not recorded. One of the best examples of this problem is the Forest Service data. Out of 731 sites on the North Kaibab Ranger District, 539 do <u>not</u> have UTMs recorded. Without UTMs it is impossible for either managers or archaeologists to use the computerized data for planning or research. Given the immense effort and cost that went into computerizing the data, this situation is indeed unfortunate. A similar situation exists with the BLM. The agency keeps a written record and maps of where surveys have been conducted but has not finished plotting the survey boundaries on a master set of USGS quadrangles. After a number of years it becomes increasingly difficult to remember where surveys have been conducted. Prior to 1984, when the need for additional compliance survey arose it was easier in some instances to simply resurvey areas rather than try to determine which parts of the proposed project had already been surveyed (Jennifer Jack, personal communication, 1986).

Our purpose here is not to lay blame or fault previous practices. Both agencies recognized these specific problems and began to address them two or three years ago. These problems, however, are symptomatic of a larger issue. The root causes of the problems are not due to the level of competence of the CRM staff or to agency-wide decisions about adequate recording levels. Instead they stem from a system that has gradually increased the demands placed on its staff to a point where it is not possible to record most sites as intensively as we are suggesting in this overview. Indeed, given the expectations of the archaeological staffs, it is remarkable how much quality work is actually accomplished.

The present situation can be improved. At a minimum both the Forest Service and the BLM need to insure that each project is entirely completed. All site forms need to be filled out completely, entered into the computer, and checked. Survey forms must be completed and logged in an appropriate manner. Each agency needs to continue to assess its own procedures. Is enough attention being given to each task? If not, is it because not enough time has been allocated? Is it because paraprofessionals need more training? Whatever the problems, both agencies must continue to address the issue of data recording. At present it represents the most important opportunity for improving the CRM programs of both the BLM and the Forest Service (see Chapter 10).

The third step in the process is integrating newly collected data into the existing database. Each agency records around 100 sites per year. Integrating these data with the 2,500 already recorded components (which, of course, do not include about 1,200 sites from the Grand Canyon National Park) is a major task. To date, Abbott's (1979) study of the Kaibab National Forest is the only attempt to integrate CRM data collected on disparate compliance surveys into a coherent argument.

The major factor limiting data integration is time. Forest Service and BLM archaeologists are working nearly full time to perform compliance work, to say nothing of synthesizing or evaluating the data. From a manager's perspective, the idea of allocating more resources to the archaeological staff so that time could be spent integrating small-scale surveys into a larger data base may seem unattractive and unnecessary. We would argue, however, that without data synthesis, the cultural resource data will never be more than simply locations. The BLM and the Forest Service will not be able to assess the potential of their cultural resources to be actively researched and interpreted. At this point, a manager might ask, how often does data integration and synthesis have to be done; every survey, every month, every year? Unlike fieldwork, data synthesis is not easily quantified. More to the point, unless integration and synthesis are made part and parcel of CRM procedures, it is all too easy to relegate these activities to the back burner.

In the next chapter, we propose a method to enhance data integration and make it part of the CRM process. We make no pretense that ours is the only method or even necessarily the best method; only that it is a method that can be incorporated into the existing CRM programs of both agencies on the Arizona Strip without causing major changes in structure or needing increases in funding.

CHAPTER 9

MODELING AS A MANAGEMENT STRATEGY

Jeffrey H. Altschul

Models and modeling have been major topics of discussion in cultural resource management (CRM) for the last decade. For managers who have seen considerable sums expended on cultural resources with no indication that these costs will diminish in the near future, modeling has been presented at a minimum as a means by which one can plan for and assess the costs of projected CRM studies and in certain cases as a substitute for Class III compliance survey. For archaeologists who have been conducting compliance study after compliance study and who have been building a seemingly endless inventory of cultural resources, modeling offers the opportunity to meet the spirit of the cultural resources laws; that of making substantive contributions to our understanding of prehistory and history.

It is beyond the scope of this discussion to review the history of modeling as it pertains to CRM. Such reviews exist and can be consulted by interested readers (e.g., Judge and Sebastian 1986). It is important here, however, to discuss the different views that management and researchers have of modeling and how these perceptions have structured the debate about how models should be used and the practical application of models in CRM. At the outset it should be noted that the views expressed here are those of the author. They do not necessarily represent those of the other authors of this volume nor are they based on an exhaustive review of the literature; they are simply those of one individual who has traveled down the 'modeling path' in CRM studies for some years now.

The Toy Airplane Model

In the past decade, Requests for Proposal (RFPs) have been distributed by numerous agencies calling for the development of prehistoric models of site location. In many cases the specifications outline well thought out probabilistic sample surveys, the results of which are used to derive statistically based models of site location. In some cases a phased approach is taken such that a survey is conducted, a preliminary model is developed on the basis of the survey results, and then a second survey is conducted whose results are used to test and refine the model. The models can be quite sophisticated and the modeling process very involved. The final model, which is often in the form of a map, is usually perceived as <u>the</u> word on site location, the end product. There is usually no mechanism to update the model with new data. Instead, when an area of proposed development is evaluated, the model is reviewed and the likelihood of encountering a site is determined. Once developed, the model is treated as immutable. Much like a toy airplane model, after a predictive model is built it can be placed on the shelf, not to be altered or modified.

The Scientific Model

A scientific model is primarily a heuristic analytic tool. Models consist of a series of posited relationships between two or more variables. The variables and relationships are chosen so that the model mimics in certain key ways the behaviors of the phenomenon under study. One of the attractive features of models from a scientific standpoint is that one can study how a change in one or more components will affect the final state of the phenomenon; that is, one can predict the behavior of the phenomenon being modeled.

Models can be as simple as a bivariate regression line or as complicated as the multivariate analyses of the nation's gross national product. What distinguishes a scientific from a toy airplane model has nothing to do with complexity or composition. Instead the two types are distinguished by the developer's attitude toward the model building-process.

The hallmark of a scientific model is that it is a dynamic analytic device. Models are based on the best guess as to the inner workings and the component parts of a particular phenomenon or class of phenomena. These "guesses" are treated as hypotheses and continually tested. In time most hypotheses are refined or replaced with new ones and as the constituent hypotheses are altered the models are refined. A specific model is never treated as an end point, but rather as the best model of a phenomenon at a particular point in time. The emphasis in scientific modeling is clearly placed on the process and not the product.

Modeling, Management, and the Archaeological Community

During the late 1970s and early 1980s there were substantial discussions among managers and archaeologists alike about the potential use of models, especially models that predicted the locations of sites. In retrospect, it appears that the respective parties spent a good deal of time talking past each other and not to each other. For the most part managers were looking for a mechanism that would increase the efficiency of compliance survey. In contrast, many archaeologists involved in the initial development of CRM predictive models had little or no understanding of management concerns and constraints, and viewed the endeavor principally as a natural extension of settlement pattern analysis (e.g., Kvamme 1983; Altschul 1983; Hurlbett 1976; Lafferty et al. 1981; Cordell and Green 1983; Brown 1981).

During the developmental stage, archaeologists were left pretty much alone regarding theoretical debates about how models should be developed or structured. It was only after the initial models were developed and the question of application arose that differences in perspective became apparent. Until that time many archaeologists (the author included) had assumed that the models were being developed primarily as planning tools. In most cases, the assumption proved correct. But in time there was increasing pressure to use the models for more than planning. On some projects, the assumption was made that we knew enough about site location based on Class II surveys that we could confidently trust the predictions of the models. Where these models predicted "no sites" the inclination was to use that prediction in lieu of a survey, or at least to change the sampling fraction.

The disparate views reached a head in a number of well publicized projects such as the McKinley Mine Coal Lease (see papers in Tainter 1984). In the past few years, there have been attempts to reconcile different views on modeling, but there has been no clear consensus (e.g., Judge and Sebastian

1988). One of the basic problems is that there has been no attempt to interface the needs of management and the goals of the scientific community in modeling approaches. It has always been one or the other that has been emphasized.

The Arizona Strip presents the opportunity to mesh the practical needs of management with the scientific goals of archaeology. In Chapter 8 we argued that data synthesis and integration must form a part of the CRM process. Without this step the CRM programs of the Forest Service and the BLM will remain largely reactive approaches that rely heavily on Class III compliance work.

To shift the orientation of the CRM programs we must develop an approach that integrates management needs into an ongoing program of scientific modeling. Prior to developing such an approach, it is clear that we must know what "management needs" are. In 1983 the senior author asked A.E. Rogge, then Project Archaeologist for the Bureau of Reclamation's Arizona Projects Office, what types of information federal agencies could use from predictive models. Rogge responded that what federal land managers would find useful was not site densities or even site locations; what managers need to know is where the "red flags" are.

From a legal perspective, a red flag might be considered any site eligible for inclusion in the National Register of Historic Places. In practice, we probably want to restrict the definition to sites likely to be affected by competing land uses. After all, many sites deemed eligible for the National Register can be avoided by project impacts. If necessary, some can be tested and excavated relatively inexpensively. For managers, the real conflicts arise not with these sites, but with those that will cause project delays and for which data recovery would be very costly; these are the "red flags."

There are two types of red flag sites. First, there are the known red flags. These are sites that everyone agrees are important. Examples from around the Southwest include sites such as Snaketown, Pueblo Bonito, and Cliff Palace. On the BLM and Forest Service portions of the Strip, known red flags would include Antelope Cave and the Jacob Lake Ranger Station. For managers these sites are known quantities. They are precisely located and have a high priority for protection.

The second type of red flag sites are those that do not fit expected distributional patterns. Virtually all predictive models developed to date emphasize site locations that can be predicted. Predictive models are generally evaluated on the basis of accuracy alone. A model is judged to be successful if it correctly predicts where sites will be located and where they will not be located 80 or 90 percent of the time. Although accuracy is important, it is not necessarily very useful to either archaeologists or managers. Predictive models in CRM have been based on the observation that in most regions, sites tend to cluster around certain environmental features. This observation is not new; indeed it has been part of most field archaeologists' "baggage" for over a century. Sophisticated models that capitalize on this fact may be interesting, but generally do not produce results that archaeologists in the field have not known for years.

What these models can do, however, is highlight sites that are located in areas where sites are generally absent. These sites are clearly the results of behaviors that at present do not fit our models of why prehistoric inhabitants settled where they did. Under any definition, these sites must be significant, for they, more than any others, have the potential of telling us something about prehistory that was heretofore unknown.

The basic difference between previous predictive models and red flag models is not the change in emphasis from accuracy to anomalies, but the shift from a toy airplane to a scientific modeling approach. Once anomalies, or red flags, are identified, they may become the subject of additional research. As patterns are found, many anomalies can be incorporated into the model. As the model becomes more refined, those anomalies that remain red flags grow in significance. Archaeologists want to know about these sites to further our insight into the past. Managers want to know where these sites are so that they can be included early on in project plans.

Beyond project-specific application, red flag modeling is attractive because it provides an approach for incorporating modeling as a management tool. By providing an areal context from which to view the data, modeling allows the BLM and the Forest Service to integrate the scores of sites both agencies record each year together with the existing database into their proper cultural contexts. If modeling procedures are routine enough, they can be incorporated into the standard compliance procedures.

RED FLAG MODELS

Although the conceptual framework of red flag models has been presented, the procedural aspects have not. This section outlines those procedures using two examples, which represent different archaeological situations and different areas of the Arizona Strip. The first example is the Mount Trumbull area. The modeled area encompasses portions of four U.S.G.S. 7.5-minute quadrangles (Figure 61). In all, 228 prehistoric components have been recorded in the modeled area. Many of these were recorded by the Museum of Northern Arizona (MNA) during a 25 percent sample survey of 9,000 acres (Moffitt and Chang 1978). The survey was designed to provide representative coverage of the area; clearly the stuff of predictive models. The remainder of the components were recorded on various compliance surveys conducted by or for the BLM.

The second example utilizes portions of the Big Springs 15-minute quadrangle on the Kaibab National Forest (Figure 62). Although the number of recorded components is comparable to Mount Trumbull, the entire database in the Big Springs area is the result of Class III compliance surveys. There is no reason to assume that there is representative coverage of environmental zones or that site types are proportionately represented. The Big Springs database, although certainly not ideal from a research perspective, is typical of the modeling situations the BLM and the Forest Service are likely to encounter on the Arizona Strip.

The red flag models utilized in this report were developed using a geographic information system (GIS). The specific system used is known as GIMS (Geographic Information Management System) and was run on Digital Equipment Corporation's VAX computer, owned and operated by Dames and Moore. In perhaps its simplest form, a GIS can be considered a database manager for spatially arrayed data. For a cell-based system (which is the only type of GIS that will be considered here), the computer superimposes a regular grid over a region. Cells, also termed pixels, can vary in size from very small to large, with the only size limitations being imposed by the memory capabilities of the computer or the software. The grid encompassing all of the Arizona Strip used in Chapter 7 had cells about 250 m on a side. For the Mount Trumbull and Big Springs regions, the cells represent about one acre, or approximately 64 m on a side. The size of the cell for these regions was not limited by computer capabilities, but rather was a function of the resolution of the data. In this case the primary environmental data had been collected in one acre increments. Thus, it would be misleading to divide the area into finer divisions. Each dimension of interest (e.g., environmental features such as elevation) is placed in a separate file. These files are called thematic layers. Within each layer the data are stored as numeric values, with each grid cell being assigned one and only one value per thematic layer. For example, if one layer in a GIS is "location of archaeological sites," then all cells that contain sites may be coded 1, while all cells which do not contain sites may be coded 0. The system can also handle multi-state or continuous variables. In the case of archaeological resources, 0 may indicate no sites present, 1 may signify Basketmaker II sites, 2 may be assigned to Pueblo I sites, and so on. For

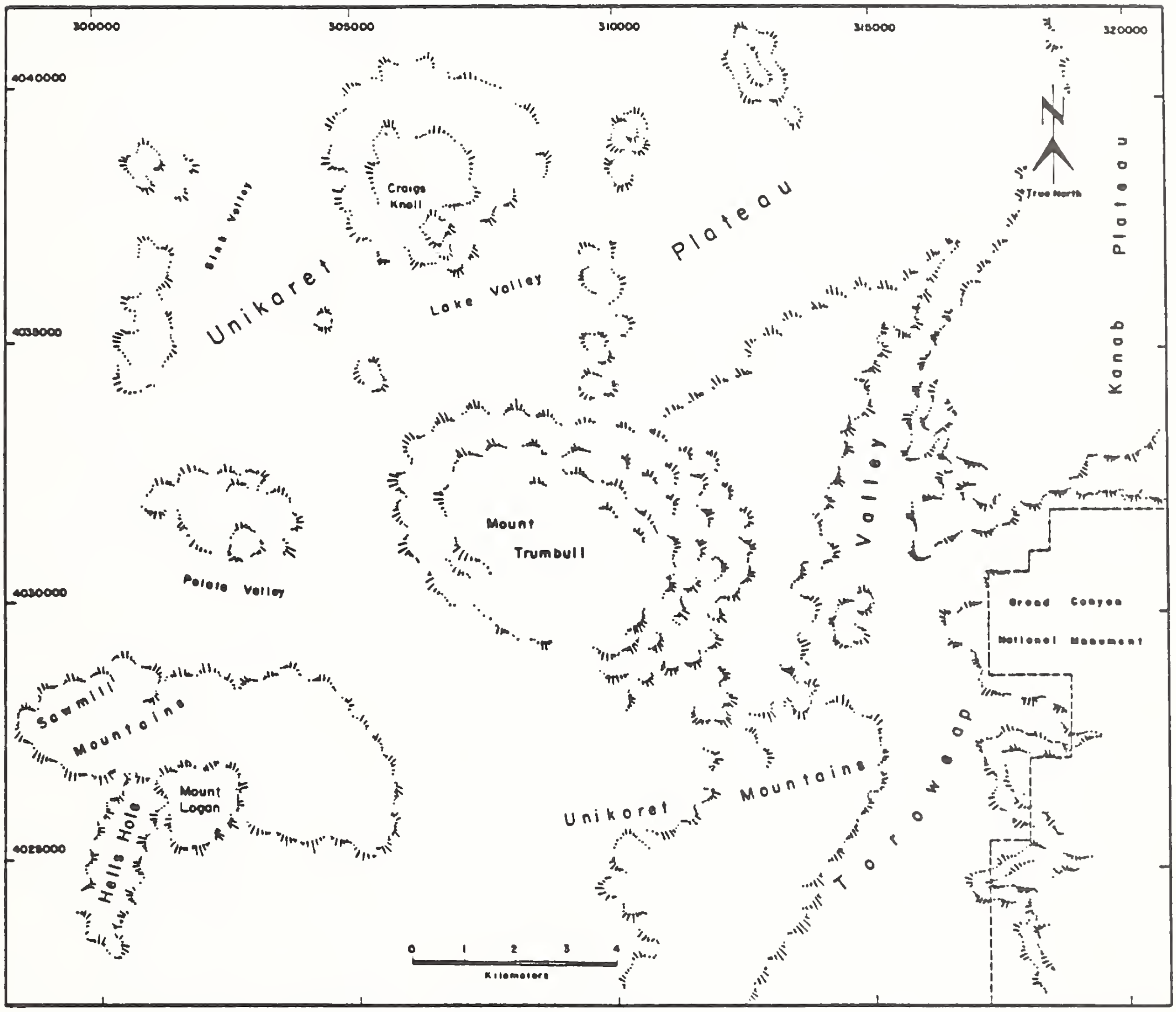


Figure 61. Mount Trumbull Study Window.

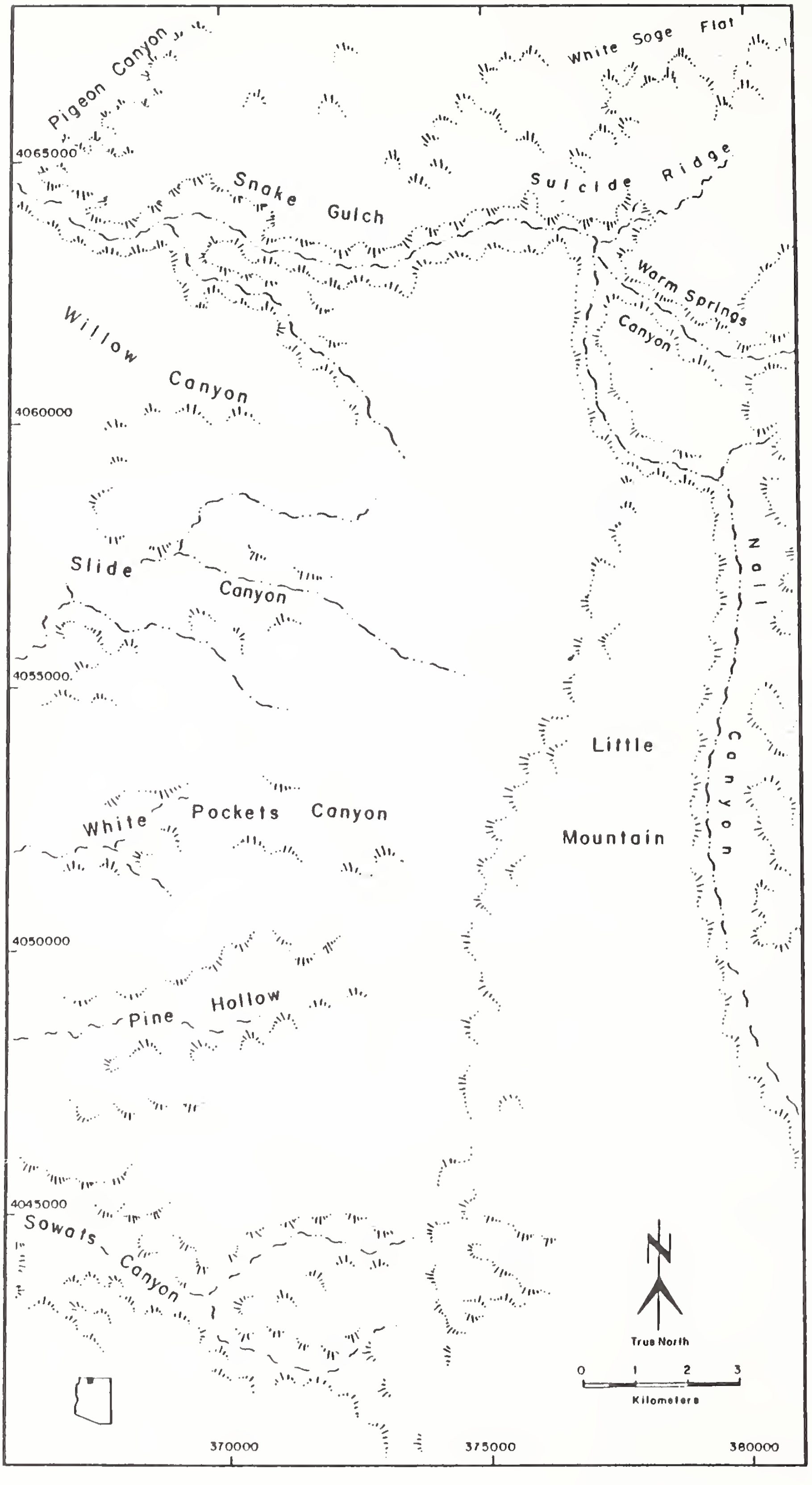


Figure 62. Big Springs Study Window.

continuous data, such as elevation, the cells are assigned a number based on their distance between digitized contours.

One powerful aspect of a GIS is its ability to use primary layers to create new layers. For instance, slope and relief can be computed directly from the elevational contour layer and the new values stored in a separate layer. From a GIS perspective, then, a region can be considered as a set of spatially arranged cells (or cases), each of which is characterized by its scores on a number of layers (or variables).

The real power in a GIS is its ability to manipulate and display vast amounts of data. Virtually all systems can compute basic statistics, such as frequencies and percentages. More advanced systems can compute regression and correlation coefficients as well as a host of spatial analyses, such as neighborhood analysis and path searching. One of the most widely used features of a GIS in cultural resource management is the ability to overlay different layers to create composite images. For example, site locations can be correlated individually with different environmental features. Each correlation will result in a map displaying areas where sites covary with that particular feature. The correlation maps can then be overlaid on each other to create one composite map.

Although there is nothing inherent in the modeling procedures that necessitates the use of a GIS, we opted for this approach for two related reasons. First, both the Forest Service and the BLM have GIS capabilities that are presently underutilized at the District and Forest levels. It was generally acknowledged by members of both agencies at the outset of this project that the overview would be a useful vehicle for demonstrating the applicability of a GIS to cultural resource management on the Arizona Strip. Second, we wanted to demonstrate the potential of using pre-existing databases in modeling efforts. One of the major problems with GIS encountered by archaeologists is that the initial costs of developing working databases are often prohibitive. Usually, databases are hand digitized. An individual codes into the computer all the data for primary levels, such as site locations, site types, stream courses, vegetation, and elevation. Even for a small area this task is considerable. For a region the size of the Arizona Strip, the effort would be heroic.

Often when agencies reach this point, they abandon their commitment to GIS. At the forest and district levels, the agencies simply are not in a position to digitize vast areas without cause (i.e., impending development). One of the goals of this project is to demonstrate that modeling can still be a viable management and research tool without necessitating large initial costs.

The models developed here were created out of five databases (Figure 63). Three of these databases contained information on the archaeological sites. The primary database was the codesheet file created for this project, which is described in Chapter 7. For each component, this file contains the site identification, site type, and temporal affiliation. This information was then merged with UTM data obtained from AZSITE for BLM sites and the Forest Service CRM file and subsequent hand-digitized data for Forest Service sites.

Once the data from the three archaeological databases were merged, we were able to produce a variety of maps for the Strip as a whole and for each of the modeled areas. Many of the Strip-wide plots were presented in Chapter 7; those for the modeled areas will be provided here. These plots are primarily descriptive, showing such information as site locations by site type or time period, or a cross-tabulation of site type by time period.

The fourth database used to develop the regional models consisted of the areas surveyed in both the Big Springs and Mount Trumbull regions. This information was supplied on USGS quadrangle maps, which were then digitized. This information was used primarily to determine whether the areas that had been surveyed were representative of the environment as a whole.

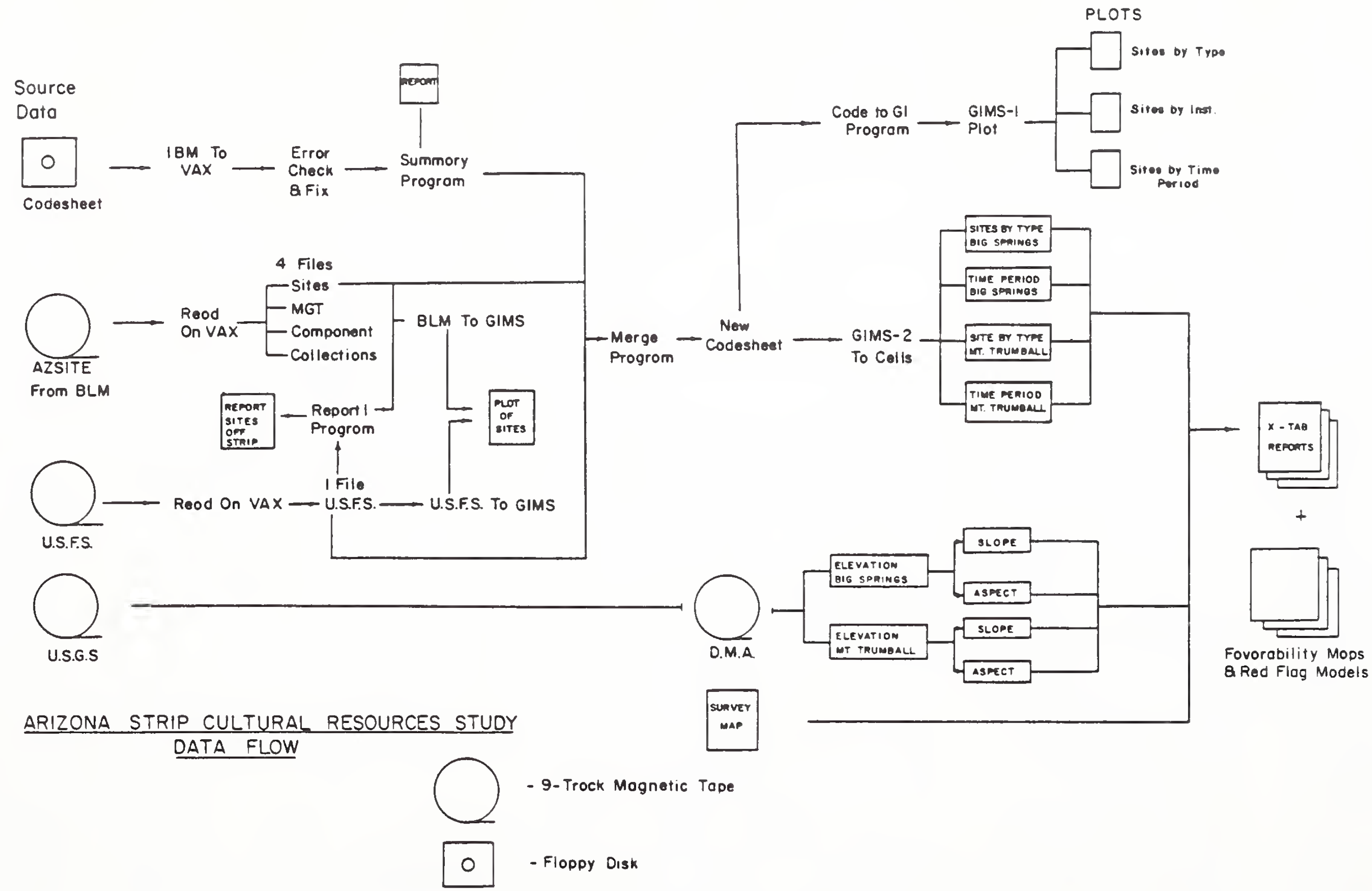


Figure 63. Project Data Flow.

The fifth database was composed of elevational data. These data were obtained from a 1:250,000-scale Defense Mapping Agency (DMA) Digital Terrain Tape. Although DMA tapes are generally being replaced by finer scale USGS (1:24,000) Digital Elevation Model (DEM) tapes, DEM tapes were not available for either the Mount Trumbull or Big Springs areas at the time of the modeling exercise, although they are now.

The DMA tapes allowed us to create three environmental variables. The first is elevation, which simply consists of the data on the tape. The other two are secondary variables, created by transforming the elevational data. These variables are slope, measured in percent grade, and aspect, a nominal variable created by dividing the compass into eight equal quadrants for components that have an exposure and a ninth value, flat, for those components lying on level surfaces.

Different GISs are likely to compute secondary variables through different algorithms. Thus, even though they start with the same data (in this case the elevations supplied by a DMA tape), two GISs are likely to produce different slope themes. Knowing how the particular GIS computes various secondary themes can be crucial in interpreting the results. For example, to devise a slope score for an individual cell, or pixel, in GIMS, the computer searches the eight pixels surrounding the one in question and computes an average slope for that pixel. Because each pixel is approximately 60 X 60 m in dimension the slope score is calculated over a 120 m in the north-south and east-west direction and about 170 m in the diagonal directions. Slope in this case refers to a "regional" slope and not a site specific calculation. Thus, it is not uncommon in mountainous terrain to find a site with a slope score of 20 degrees or more, when in actuality the site is located on a relatively flat surface.

Finally, it is worth mentioning the variables not used in this analysis. Most predictive models include one or more variables measuring aspects of hydrology, vegetation, soil, and topography. We did not include these variables for two reasons. First, each would have to be hand-digitized and the primary goal of the modeling exercise is to show what can be learned without additional digitizing. Second, the modeling aspect of this project is a demonstration. Our goal is to show federal archaeologists and managers an approach, not a finished product. Using only three variables, although limiting the power of the models developed, keeps the discussion relatively simple.

Once the individual databases were obtained, we were able to proceed with the red flag models. The first step in the process was to examine the descriptive results to identify obvious patterns. For example, the Mount Trumbull and Big Springs databases were searched for temporal patterns, such as a shift between Basketmaker III and Pueblo I components in preferred elevational settings. We also examined the database for differences between site types and environmental location. Finally, when warranted by an adequate number of components, we studied the covariation of site types by environmental variable by time period.

The data exploration described above was conducted through the use of simple cross tabulations. No statistics more complicated than Chi-square were employed. This type of analysis, albeit simple and straightforward, is a necessary precursor to all types of modeling.

The second step in the modeling process is to examine the environmental variables. These variables need to be studied for their coverage and for the degree of spatial independence. As to the first concern, we need to assess whether existing surveys have covered each environmental variable proportionally or whether particular zones have been disproportionally under- or over-covered. For example, in the Mount Trumbull area seven elevational zones have been defined. One of these is the area lying between 2,900 and 5,900 ft. This zone constitutes almost 15 percent of the modeled area. If site locations were not correlated with elevation, we would expect nearly 15 percent of all sites to be found in this zone. Upon examination, however, we find that only 0.1 percent of this zone has been surveyed. Thus, the fact that no sites have been located in this zone does not necessarily indicate an absence of sites, only that no survey has been done here.

The opposite situation, in which an area is over-sampled, can also be troubling. Using Mount Trumbull again as an example, we find that the 6,400 and 6,600 ft. band covers only 7.4 percent of the study universe, but that 22.5 percent of this zone has been surveyed. In this zone 78 components, or 36 percent of the number of components found in the study window, have been recorded. If no relationship existed between site location and this elevational zone, we would expect about 7.5 percent of the sites in the entire study window to be located here. Because this zone has been oversampled, however, we need to know what percentage of sites should be expected given the survey coverage. Of all areas surveyed on the Mount Trumbull study window, 17.8 percent lie in this zone. Thus, we would expect about 18 percent of the total number of recorded sites to be found in the 6,400 and 6,600 ft. band due to chance alone. The fact that the proportional representation of sites in this zone is double the expectation is strong evidence that the large number of components found in this zone is not simply due to survey coverage, but actually reflects cultural preference.

Once we have determined which zones have over, under, or proportional survey coverage, what do we do? Areas surveyed in proportion to their size usually pose no problem; we simply generalize the results to the entire zone. The only exceptions to this rule are very small zones. For example, a zone of 1,000 acres representing 1 percent of a study window would require only 10 acres of survey to provide proportional coverage. Generalizing the survey results in this case would probably not be very useful. In addition to proportional coverage, then, a minimum amount of survey needs to be established. This minimum standard will depend on the size of the zones; for areas with zones as small as 1,000 acres we may want at least 20 percent of the smallest zones surveyed before they enter into the analysis, while for areas where the smallest zone is 10,000 acres, a 10 percent standard would suffice.

Dealing with under- and over-sampled zones have caused problems for archaeologists. Some investigators (e.g. Kvamme 1988) have suggested statistically weighing zones by a "coverage" factor. Site locations from undersampled zones count somewhat more than they would if the zone had proportional coverage, while site locations from oversampled zones carry somewhat less weight in subsequent quantitative analyses. The major problem with the weighing approach is that nonrepresentative samples are combined and manipulated as though they were selected from a probabilistic sampling design. By transforming and smoothing the data over the entire sampling universe, problems with individual zones are marked.

We prefer a more straightforward approach. Over-sampled zones cause no problem as long as the minimum survey standard discussed above is met. The only important point to remember is that determining whether more or fewer sites are recorded than expected must be calculated on the basis of how much of the total area surveyed the zone represents, as opposed to how much of the total land area the zone represents. Undersampled areas are deleted entirely from the analysis. We see no reason to mask the fact that not enough is known about site location in these zones to have any confidence in generalizing the results. This approach does not try to smooth regional trends to provide areal coverage; instead, areas in need of additional survey are starkly presented.

Our second concern with environmental variables is the issue of spatial independence. In the past, many archaeologists have developed predictive models by first developing maps, which display for each variable areas where sites are found and areas where sites are absent and then simply "sandwiching" the maps on top of each other to create a composite map of "environmentally favored zones" and "environmentally unfavored zones" (e.g. Kohler et al. 1980, Thomas et al. 1981). Although intuitively attractive, there are serious logical flaws with this approach (Altschul 1988). Most environmental variables covary. Well-drained soils are associated with level land, certain vegetative communities, and specific topographic features. Thus, although each variable may be correlated with site location, it does not necessarily follow that the intersection of these correlations is a better predictor of site locations than each variable individually. To demonstrate the latter, one has to determine the correlation between site location and each feature, controlling for all other environmental variables. This control can be accomplished statistically through such techniques as partial correlation or multiple regression.

A simpler alternative is to examine the covariation of individual pairs of environmental variables. For example, we can calculate a Pearson's r correlation coefficient between elevation and slope for each grid square, or pixel, in the modeled area. A high or low r score, say 0.7 or higher, or -0.7 or lower, indicates that the two variables covary closely; a positive score indicating that as elevation increases so does the degree of slope and a negative score indicating that as elevation increases, the degree of slope decreases. For variables that differ in measurement scales (e.g., elevation is measured on an interval scale, while aspect is scored on a nominal scale) different statistics are employed, but the general approach is still the same. Each pair of variables is examined. If there is only a slight spatial or no spatial relationship, creating a composite map is justified. If the two variables are strongly correlated, the favorability map is created by using just one of the variables. This approach is clearly less powerful than using a multivariate technique, it also is intuitively much simpler and much less time consuming.

The third step in the modeling process is creating the favorability maps. In this step, we take the environmental zones that covary with site locations and do not covary with other environmental variables, and display those areas that favor sites, those that do not, and those that show no correlation. These favorability rules are based on a logical scheme. For each variable a secondary layer is created of favorability scores. A pixel scores a +1 if it lies in an environmental zone that directly correlated with site location, a 0 if it lies in a zone that exhibits no relationship with site locations, and -1 if it lies in a zone where sites are indirectly correlated with the environmental zone. These favorability maps, then, consist of plots of 0, 1, and -1. The favorability maps for each environmental variable are then overlaid on each other to create a composite. By summing the three scores for each pixel we can then create an overall favorability score. For example, in the Mount Trumbull area we used three environmental variables to create the following scale; a pixel with scores of +2 or +3 (favorable on all three variables [1, 1, 1] or favorable on two variables and neutral on the third [1, 1, 0]) are classified as "favorable;" pixels scoring a +1 or 0 (favorable on two variables and unfavorable on the third [1, 1, -1], favorable on one and neutral on the other two [1, 0, 0], favorable on one variable, neutral on one, and unfavorable on one [1, 0, -1], and neutral on all three [0, 0, 0]) were designated "neutral;" pixels with a composite score of -1 (unfavorable on one, neutral on two [-1, 0, 0] or unfavorable on two and favorable on one [-1, -1, 1]) are termed "unfavorable;" and pixels scoring -2 or-3 (unfavorable on all three variables [-1, -1, -1] or unfavorable on two and neutral on one [-1, -1, 0]) are classified as "very unfavorable."

The measurement scales for Mount Trumbull and Big Springs were based on a visual inspection of the results. No attempt was made to create a priori scales based on theoretical foundations. Although we have severe doubts about the utility of "natural" scales in general, the point here is that the models being developed are analytic tools. They are meant to be dynamic and easily changed. Although the structure of the modeling process remains stable, its component parts can and should change to meet specific situations.

Once the favorability maps are developed, we are ready for the final step, the red flags. In the models developed for Mount Trumbull and Big Springs, we defined red flags as any site located in an "unfavorable" or "very unfavorable" setting. In certain situations archaeologists may want to define degrees of red flags; for example calling sites in unfavorable settings "light red flags" and those in very unfavorable locales "dark red flags." Again, the point is that what is and what is not a red flag is dependent on a variety of project specific conditions. In the models developed for Mount Trumbull and Big Springs, red flags were first listed, and then plotted by themselves and by site type. The final phase of modeling for this project then consisted of interpreting the spatial patterns and identifying avenues for future research.

The previous discussion presented an overall description of the modeling process. The specific models for Mount Trumbull and Big Springs follow.

MOUNT TRUMBULL

Step 1: Data Exploration

There are a total of 228 prehistoric components recorded in the Mount Trumbull study window. Of these, 165 date to the Formative period, one is dated to the Archaic period, 13 components are assigned to the Neo-Archaic period, and 50 components could not be dated at all. With the exception of the Formative period, there are too few data for each time period to discuss temporal patterns in site location. Within the Formative period, Anasazi components were assigned to the most specific phase possible. Virtually all the components were grouped into one of two categories; either "undifferentiated" Anasazi or Pueblo II-Early Pueblo III.

The Mount Trumbull data clearly do not allow for an analysis of change over time. Although disappointing, this situation is fairly typical of databases based on limited survey data. This situation is a graphic example of why the BLM and the Forest Service need to expend a greater level of effort recording data in the field.

Most of the components recorded in the Mount Trumbull study window are habitation sites (N=131, 59.8%). Temporary campsites account for only 14 components (6.4%), and the remaining 74 components (33.8%) could not be classified to a site type. The high proportion of habitation sites seems peculiar and may reflect more on archaeological technique than cultural behavior. In the absence of some type of subsurface testing component during survey, the likelihood of finding small artifact scatters is relatively low (Nance and Ball 1986; Lightfoot 1986). Thus, the database is almost assuredly skewed in favor of sites with obtrusive surface features such as rubble mounds and roomblocks (Schiffer and Wells 1982). In evaluating the model results, then, we need to be careful about forwarding interpretations about the overall settlement/subsistence system.

Site locations are generally correlated with the three environmental variables (Tables 16, 17, and 18). Using simple Chi-square tests with an alpha level of .05, we find that site locations are found in greater than expected frequencies at elevations between 6,400 and 6,600 feet, on surfaces with slopes of between 10 and 20 percent grades, and in areas with north or northwest exposures. Sites are absent in greater than expected numbers from areas with elevations over 7,200 ft., with slopes greater then 50 percent grade, and in locations with easterly exposures. In all other conditions, sites are represented in numbers that do not differ significantly from random. These findings are not terribly surprising; they basically corroborate the original analysis conducted by Moffitt and Chang (1978).

Step 2: Environmental Assessment

The areas surveyed at Mount Trumbull are not equally represented across all environmental zones (see Tables 19, 20, and 21). For example, only 1.2 percent of the area below 6,000 ft has been surveyed, although this area encompasses nearly 65 percent of the entire study window. In contrast, nearly 29 percent of the area between 6,600 and 7,200 ft. has been surveyed, even though this region constitutes less than 8 percent of the study window. These observations bear directly on our confidence in generalizing the survey results. Although no sites have been found below 5,000 ft., we cannot argue that sites were not located below 5,000 ft. because only 0.1 percent of this area has been surveyed. On the other hand, we can be quite confident that the survey results in the 6,600 to 7,200 ft. zone can be generalized to the entire zone.

It is important to point out that confidence in this context is not of a statistical nature. The total surveyed area represents a conglomerate of different surveys. Thus, we cannot assess the bias in the sample and cannot realistically compute variances or confidence intervals. Used in this context,

Table 16. Elevation, Mount Trumball.

	2900-5000	5001-6000	6001-6200	6201-6400	6401-6600	6601-7200	7201-8100	TOTAL
Total Area in Pixels	8747	22770	12829	6845	4770	6458	2381	64800
Surveyed Area in Pixels	5	253	638	553	1021	1845	1420	5735
Percent of Area Surveyed	0.1	1.1	5.0	8.1	21.4	28.6	59.6	8.9
Percent of Elevational Band to Total Area	13.5	35.1	19.8	10.6	7.4	10.0	3.7	100.0
Number of Components	0	18	45	39	78	44	7	231*

* 12 components are being recorded twice by GIMS. These errors do not affect the general patterns.

Table 17. Slope, Mount Trumball.

	0-5	6-10	11-20	21-30	31-50	over 51	TOTAL
Total Area in Pixels	13897	6455	11666	7604	9059	16119	64800
Percentage of Slope Band to Total Area	21.4	10.0	18.0	11.7	14.0	24.9	100.0
Surveyed Area in Pixels	926	603	1013	717	957	1519	5735
Percentage of Slope Band Surveyed	6.7	9.3	8.7	0.2	10.6	9.4	8.9
Number of Components	46	40	77	35	25	8	231

Table 18. Aspect, Mount Trumball.

	Flat	N	NE	E	SE	S	SW	W	NW	TOTAL
Total Area in Pixels	2778	6135	6967	11789	8165	5850	7652	9169	6295	64800
Percentage of Aspect Band to Total Area	4.3	9.5	10.8	18.2	12.6	9.0	11.8	14.1	9.7	100.0
Surveyed Areas in Pixels	131	751	850	862	692	445	645	561	798	5735
Percentage of Area Surveyed	4.7	12.2	12.2	7.3	8.5	7.6	8.4	6.1	12.7	8.9
Number of Components	7	64	34	22	27	8	5	16	48	231

confidence is a subjective term. As a general guideline for Mount Trumbull, we had confidence in the survey results of a zone when over 5 percent of it had been surveyed and the amount of zone that had been surveyed was higher or proportional to the zone's overall representation. Consider, for example, the elevation band of 6,200 to 6,400 ft. In this case 8.2 percent of the zone has been surveyed. The amount surveyed in this zone represents about 10 percent of the overall survey effort at Mount Trumbull, which is directly proportional to the zone's representation in the overall environment. Thus, we had "confidence" in generalizing the survey results to the entire zone.

Following these rules we find that with the exception of elevations below 6,000 ft., we can have confidence in using survey data for model building. For the two zones below 6,000 ft., we have arbitrarily set their favorability scores to 0. This score does not mean that site locations are found in numbers proportional to the area of these zones, only that we do not know enough to determine the correlation between site locations and these environmental zones.

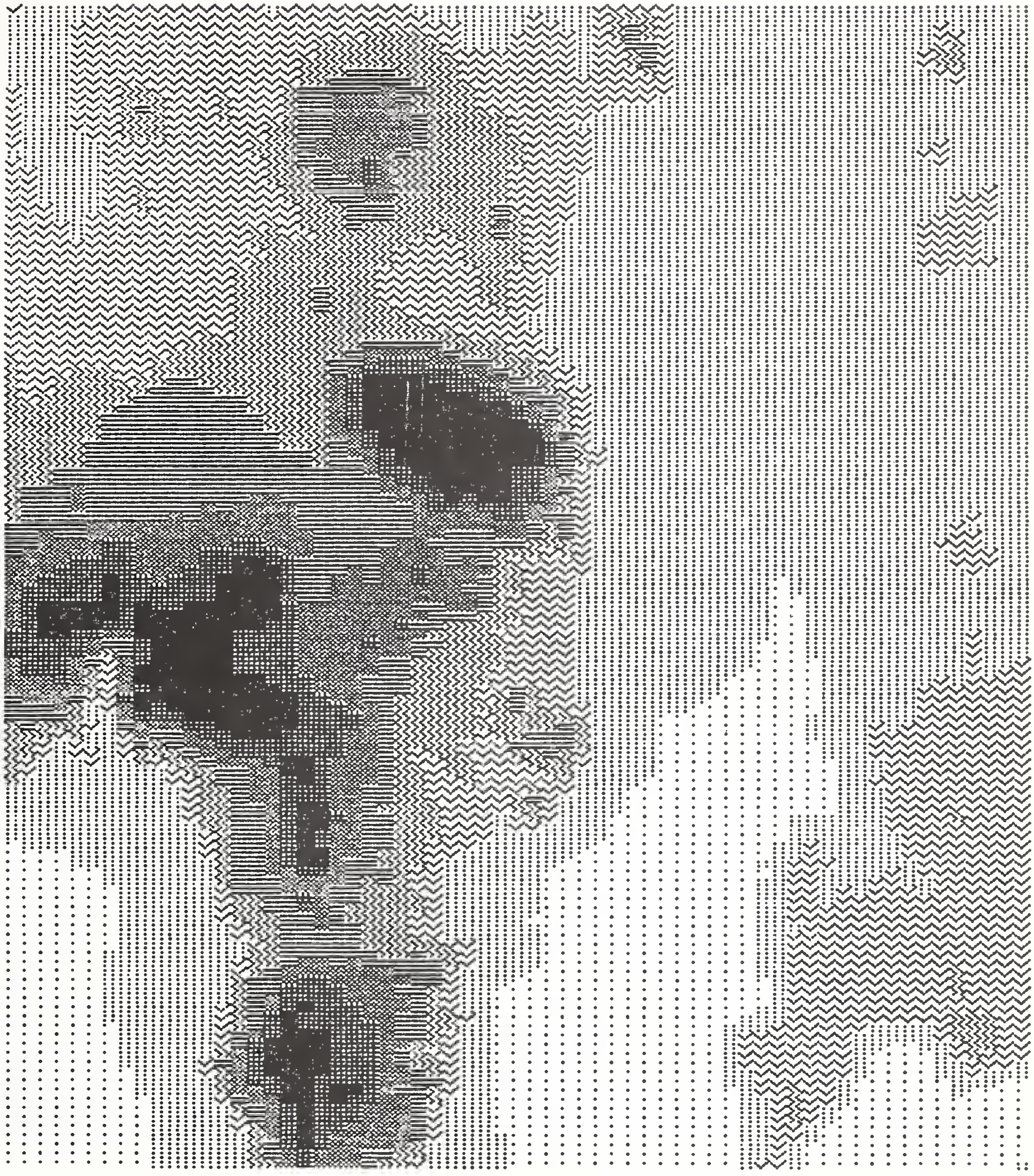
The second aspect to the environmental assessment is determining the degree of spatial independence between the three environmental zones. The first step in this process is simply to compare the three environmental maps visually (Figure 64, 65, and 66). If the same type of shaded areas tend to occur in the same places on the maps, then statistical independence is a serious problem; otherwise, the variables are not strongly correlated. After the visual examination, the nature of the relationships can be pursued statistically. For elevation and slope, a Pearson's r correlation coefficient was computed on the basis of the pixel's scores. The r score was 0.23, which indicates that there is no significant relationship between the two variables. For analyzing the relationship between aspect and the other two variables, GIMs created contingency tables (Tables 19 and 20). Chi-square computed on these tables indicate no significant relationship exists. The result of the environmental analysis is that the variables are not strongly intercorrelated, and thus all of them can be used in the model.

The procedures discussed above for studying spatial independence are relatively simple. Other, more complicated, techniques also exist for assessing the strength of relationships. For example, we could have computed a linear discriminant analysis that would have determined the strength and importance of each variable to predicting site location.We chose not to pursue this course because a) most archaeologists lack the techniques add power at the expense of simplicity. Again, the goal of this project is to provide federal archaeologists with a method that can be used in everyday management.

Step 3: Favorability Maps

To create the favorability maps, we first need to develop the rules. Using the results obtained during data exploration, we set a score of +1 to any environmental zone where sites were found in significantly greater numbers than expected, -1 to zones where significantly fewer sites than expected were found, and 0 to all other zones. At Mount Trumbull the favorability rules are summarized in Table 21.

Based on these rules, favorability maps consisting of pixels coded 0, 1, or -1, were created for each environmental variable. The three favorability maps were then overlaid on each other and the scores for each pixel examined. The pixels scoring 1 to 3 were then coded "favorable," those scoring 0 were coded as "neutral," those summing to -1 were coded "unfavorable," and those scoring -2 or -3 were coded "very unfavorable." A composite favorability map, based on these new codes, was then created. This map shown in Figure 67, shows very unfavorable locations for sites in the dark shading and increasingly favorable ratings in lighter and lighter shades.



ABSOLUTE VALUE RANGE OF EACH LEVEL

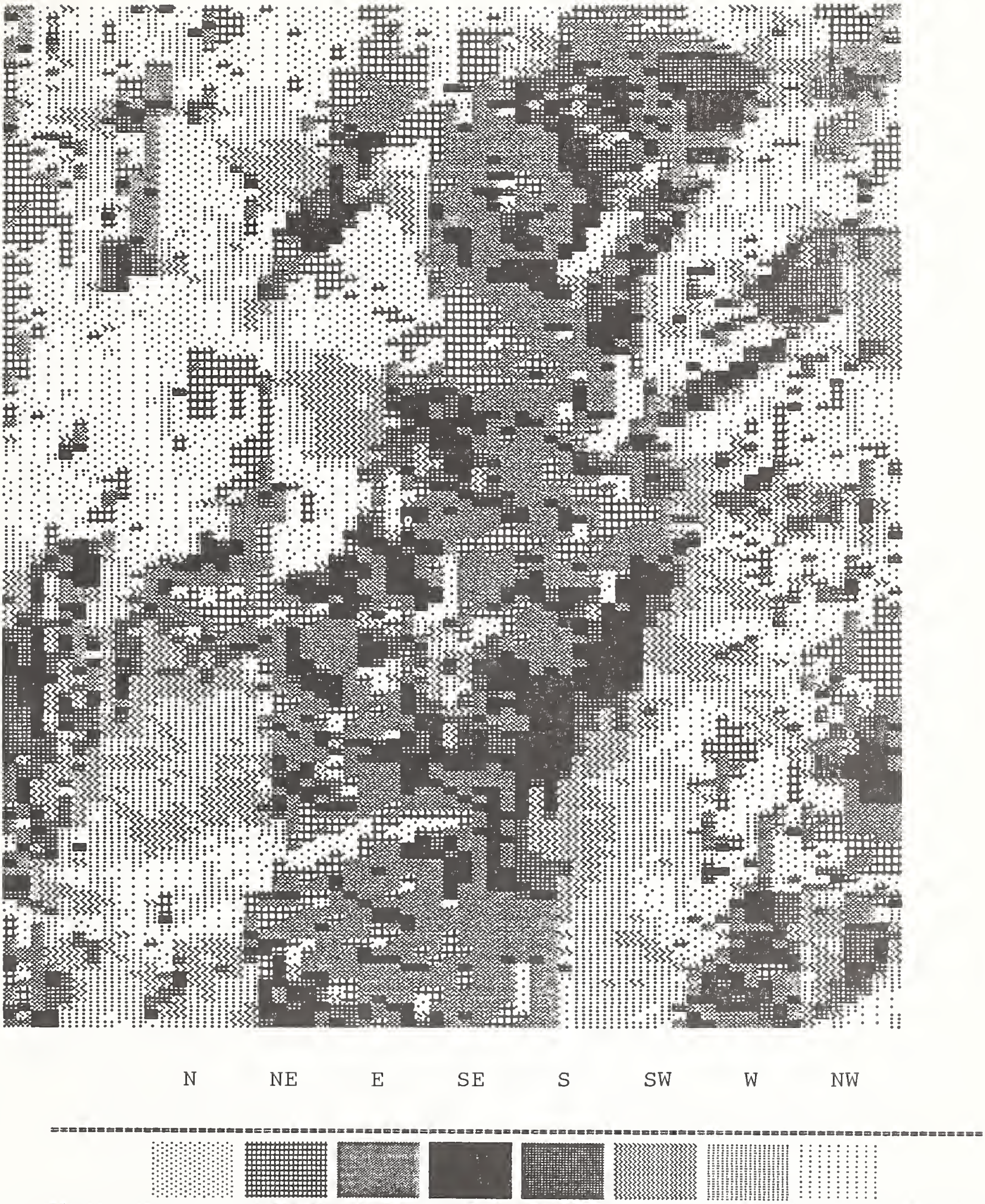
MINIMUM		2956.00	5000.00	6000.00	6200.00	6400.00	6600.00	6900.00	7200.00	
MAXIMUM		5000.00	6000.00	6200.00	6400.00	6600.00	6900.00	7200.00	8100.00	
FREQUENCY	0	8747	22770	12829	6845	4770	3911	2547	2381	0
PERCENT		13.50%	35.14%	19.80%	10.56%	7.36%	6.04%	3.93%	3.67%	

Figure 64. GIS Map of Elevation, Mount Trumbull.

ABSOLUTE VALUE RANGE OF EACH LEVEL

MINIMUM		0.00	5.00	10.00	20.00	30.00	50.00	
MAXIMUM		5.00	10.00	20.00	30.00	50.00	9999.00	
FREQUENCY	0	13897	6455	11666	7604	9059	16119	0
PERCENT		21.45%	9.96%	18.00%	11.73%	13.98%	24.88%	

Figure 65. GIS Map of Slope, Mount Trumbull.



FREQUENCY	0	8913	6967	11789	8165	5850	7652	9169	6295	0
PERCENT		13.75%	10.75%	18.19%	12.60%	9.03%	11.81%	14.15%	9.71%	

Figure 66. GIS Map of Aspect, Mount Trumbull.

Table 19. Elevation versus Aspect, Mount Trumball.

DAMES & MOORE G I M S GEOGRAPHIC INFORMATION MANAGEMENT SYSTEM VERSION 86:1 09:17:19

CROSS-TABULATION REPORT -- ASPECT WITH ELEVATION
ARIZONA STRIP CULTURAL RESOURCES STUDY
DOWN: ASPECT ACROSS: ELEVATION

TABULATION	LIMIT	2900-5000 FT	5000-6000 FT	6000-6200 FT	6200-6400 FT	6400-6600 FT	6600-7200 FT	7200-8100 FT	TOTAL
LIMIT		5000.0	6000.0	6200.0	6400.0	6600.0	7200.0	8100.0	
		7.1%	34.3%	53.7%	0.4%	2.8%	0.6%	1.2%	
FLAT	0.0	196	953	1492	10	77	17	33	2778
		2.2%	4.2%	11.6%	0.1%	1.6%	0.3%	1.4%	4.3%
		1.1%	26.2%	23.7%	15.1%	13.7%	14.8%	5.4%	
ASPECT N	1.0	67	1608	1456	926	839	907	332	6135
		0.8%	7.1%	11.3%	13.5%	17.6%	14.0%	13.9%	9.5%
		2.8%	26.4%	29.7%	13.6%	9.4%	12.9%	5.3%	
ASPECT NE	2.0	192	1841	2068	947	653	899	367	6967
		2.2%	8.1%	16.1%	13.8%	13.7%	13.9%	15.4%	10.8%
		14.3%	37.1%	20.8%	9.5%	5.2%	9.6%	3.4%	
ASPECT E	3.0	1691	4377	2451	1121	617	1132	400	11789
		19.3%	19.2%	19.1%	16.4%	12.9%	17.5%	16.8%	18.2%
		18.8%	39.1%	12.8%	11.2%	5.2%	8.6%	4.3%	
ASPECT SE	4.0	1539	3190	1047	911	426	703	349	8165
		17.6%	14.0%	8.2%	13.3%	8.9%	10.9%	14.7%	12.6%
		17.8%	45.8%	12.4%	7.4%	4.3%	8.3%	3.9%	
ASPECT S	5.0	1044	2681	725	433	253	486	228	5850
		11.9%	11.8%	5.7%	6.3%	5.3%	7.5%	9.6%	9.0%
		23.3%	36.5%	10.5%	9.6%	6.4%	9.9%	3.8%	
ASPECT SW	6.0	1786	2793	802	736	490	756	289	7652
		20.4%	12.3%	6.3%	10.8%	10.3%	11.7%	12.1%	11.8%
		20.4%	36.3%	17.4%	10.1%	6.3%	7.0%	2.3%	
ASPECT W	7.0	1875	3328	1595	930	582	646	213	9169
		21.4%	14.6%	12.4%	13.6%	12.2%	10.0%	8.9%	14.1%
		5.7%	31.8%	19.0%	13.2%	13.2%	14.5%	2.7%	
ASPECT NW	8.0	357	1999	1193	831	833	912	170	6295
		4.1%	8.8%	9.3%	12.1%	17.5%	14.1%	7.1%	9.7%
		13.5%	35.1%	19.8%	10.6%	7.4%	10.0%	3.7%	
TOTAL		8747	22770	12829	6845	4770	6458	2381	64800

SUMMARY		2900-5000 FT	5000-6000 FT	6000-6200 FT	6200-6400 FT	6400-6600 FT	6600-7200 FT	7200-8100 FT
	FREQUENCY	8747.0	22770.0	12829.0	6845.0	4770.0	6458.0	2381.0
	SUM	43597.0	100632.0	46279.0	29566.0	20643.0	27697.0	9387.0
	MEAN VALUE	5.0	4.4	3.6	4.3	4.3	4.3	3.9
	MINIMUM VALUE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	MAXIMUM VALUE	8.0	8.0	8.0	8.0	8.0	8.0	8.0
	STANDARD DEVIATION	1.8	2.2	2.5	2.3	2.6	2.4	2.2

Table 20. Slope versus Aspect, Mount Trumbull.

DAMES & MOORE G I M S GEOGRAPHIC INFORMATION MANAGEMENT SYSTEM VERSION 86:1 11:07:58

CROSS-TABULATION REPORT -- ASPECT WITH SLOPE
ARIZONA STRIP CULTURAL RESOURCES STUDY
DOWN: ASPECT ACROSS: SLOPE

TABULATION	LIMIT	0-5 PER CENT	5-10 PER CENT	10-20 PER CENT	20-30 PER CENT	30-50 PER CENT	OVER 50 PER CENT	TOTAL
		5.0	10.0	20.0	30.0	50.0	9999.0	
		99.9%	0.0%	0.0%	0.0%	0.0%	0.0%	
FLAT	0.0	2776	0	1	0	1	0	2778
		20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%
		16.2%	18.2%	23.2%	11.9%	11.3%	19.2%	
ASPECT N	1.0	994	1118	1421	727	695	1180	6135
		7.2%	17.3%	12.2%	9.6%	7.7%	7.3%	9.5%
		18.5%	13.9%	20.7%	12.8%	12.9%	21.2%	
ASPECT NE	2.0	1288	971	1445	889	900	1474	6967
		9.3%	15.0%	12.4%	11.7%	9.9%	9.1%	10.8%
		17.1%	8.5%	22.6%	13.8%	16.3%	21.7%	
ASPECT E	3.0	2013	1006	2666	1626	1921	2557	11789
		14.5%	15.6%	22.9%	21.4%	21.2%	15.9%	18.2%
		12.5%	11.6%	20.0%	11.1%	15.3%	29.5%	
ASPECT SE	4.0	1022	947	1630	903	1253	2410	8165
		7.4%	14.7%	14.0%	11.9%	13.8%	15.0%	12.6%
		23.3%	11.1%	15.5%	9.4%	14.2%	26.5%	
ASPECT S	5.0	1361	648	908	549	833	1551	5850
		9.8%	10.0%	7.8%	7.2%	9.2%	9.6%	9.0%
		24.6%	5.4%	11.7%	11.2%	14.4%	32.7%	
ASPECT SW	6.0	1880	412	897	855	1102	2506	7652
		13.5%	6.4%	7.7%	11.2%	12.2%	15.5%	11.8%
		18.1%	8.8%	14.3%	13.0%	15.8%	30.0%	
ASPECT W	7.0	1659	810	1310	1188	1449	2753	9169
		11.9%	12.5%	11.2%	15.6%	16.0%	17.1%	14.1%
		14.4%	8.6%	22.0%	13.8%	14.4%	26.8%	
ASPECT NW	8.0	904	543	1388	867	905	1688	6295
		6.5%	8.4%	11.9%	11.4%	10.0%	10.5%	9.7%
		21.4%	10.0%	18.0%	11.7%	14.0%	24.9%	
TOTAL		13897	6455	11666	7604	9059	16119	64800

SUMMARY		0-5 PER CENT	5-10 PER CENT	10-20 PER CENT	20-30 PER CENT	30-50 PER CENT	OVER 50 PER CENT
	FREQUENCY	13897.0	6455.0	11666.0	7604.0	9059.0	16119.0
	SUM	50627.0	25592.0	49025.0	34122.0	41430.0	77005.0
	MEAN VALUE	3.6	4.0	4.2	4.5	4.6	4.8
	MINIMUM VALUE	0.0	1.0	0.0	1.0	0.0	1.0
	MAXIMUM VALUE	8.0	8.0	8.0	8.0	8.0	8.0
	STANDARD DEVIATION	2.6	2.3	2.3	2.2	2.1	2.1

Table 21. Favorability Rules for Mount Trumbull.

	Favorable +1	Neutral 0	Unfavorable -1
Elevation	6,400-6,600	2,900-6,400,6,600-7,200	7,200-8,100
Slope	10-20	0-10, 20-50	50+
Aspect	N,NW	all others	E

Step 4: Red Flags

Once the favorability map is created, the next step is to cross-tabulate site locations with favorability zones. These cross-tabulations are presented by site-type in Tables 22, 23, and 24). For habitation sites 93 components (71%) were found in favorable locations, 20 (15%), were found in neutral areas, 17 (13%), were located in unfavorable settings, and only 1 (0.8%), was found in a very unfavorable location. The distributions of temporary camps and unknown site type components follow the same trend.

Although it is reassuring that over 70 percent of all component locations can be predicted with just three variables, our interest at this point focuses on those components that fall in the unfavorable or very unfavorable settings. A list of these components is provided in Table 25, and a plot showing the distribution of these components is presented in Figure 68. In examining the results, we first divided the sites by time period (Table 26). Formative and undated components have approximately the same proportion of red flags, about 13 or 14 percent. In contrast, Neo-Archaic components, which are all affiliated with Paiute occupation of the region, had nearly triple the proportion of red flags. In studying the distribution of Paiute red flag sites, and of Paiute sites in general, we found that the occupation of the Mount Trumbull study window during the Neo-Archaic period was focused on the east flank of the Uinkaret Mountains and in the Toroweap Valley. The Formative occupation followed a very different pattern, concentrating on the western slopes of Mount Trumbull and the Uinkaret Mountains. The placement of Pauite sites as red flags is understandable in terms of the construction of the model. The model is heavily weighted with Anasazi data and therefore is a better predictor of this culture than any other. Though understandable the finding is still intriguing. Why would the Paiutes concentrate on one side of the mountains and the Anasazi the other? At this point we just do not have a good answer.

A second interesting aspect to the red flags concerns the Anasazi habitation components (Figure 69). Of the 23 Anasazi red flag components, 18, or nearly 80 percent, were habitation components. This percentage is substantially higher than the overall percentage of habitation components (60 percent). Of the 18 habitation red flags, 9 consist of components with 5 rooms or less. Most of these small components were probably used as field houses. Nine of the components, however, are relatively substantial habitations, with four being C- or L- shaped pueblos and two others containing over 20 rooms in one block.

The distribution of the larger habitation components is interesting. Three components (A2 A:12:52 [MNA], 53 [MNA], and 143 [BLM]) form a tight spatial cluster along the southwestern base of Mount Trumbull. Two of these sites (52 and 53) also contained Paiute components, suggesting that the desirability of these locales transcended time and culture. In studying the USGS quadrangle, however, there is nothing at these locations that is especially noteworthy. There are no springs in the immediate area nor even a reliable water source. At present we have no good explanation for these sites; they are truly enigmatic. It is reasonable to assume, however, that a cluster of large multicomponent sites is indicative of strong, culturally patterned behavior. The research value of this area is high, and to managers it should be shown as a "dark" red flag.

SYMBOL CODE	DESCRIPTION
1	FAVORABLE
4	NEUTRAL
7	UNFAVORABLE
10	VERY UNFAVORABLE

SYMBOL		10	7	4	1	
FREQUENCY	0	5618	18821	24570	15791	0
PERCENT		8.67%	29.04%	37.92%	24.37%	

Figure 67. Favorability Map, Mount Trumbull.

Table 22. Habitation Components by Favorability Zone, Mount Trumball.

		Very Unfavorable	Unfavorable	Neutral	Favorable	Total
Surveyed-- No Site	N	758	1555	1427	1980	5720
	%	13.3	27.2	24.9	34.6	100.0
Site	N	1	17	20	100	138
	%	0.7	12.3	14.5	72.5	100.0

Table 23. Base and Temporary Camps by Favorability Zone, Mount Trumball

		Very Unfavorable	Unfavorable	Neutral	Favorable	Total
Surveyed-- No Site	N	758	1568	1438	2041	5805
	%	13.1	27.0	24.8	35.2	99.9
Site	N	1	1	4	8	14
	%	7.1	7.1	28.6	57.1	99.9

Table 24. Limited Activity and Other Site Type Components by Favorability Zone, Mount Trumball.

		Very Unfavorable	Unfavorable	Neutral	Favorable	Total
Surveyed-- No Site	N	757	1558	1433	2014	5762
	%	13.1	27.0	24.9	35.0	100.0
Site	N	2	12	11	51	76
	%	2.6	15.8	14.5	67.1	100.0

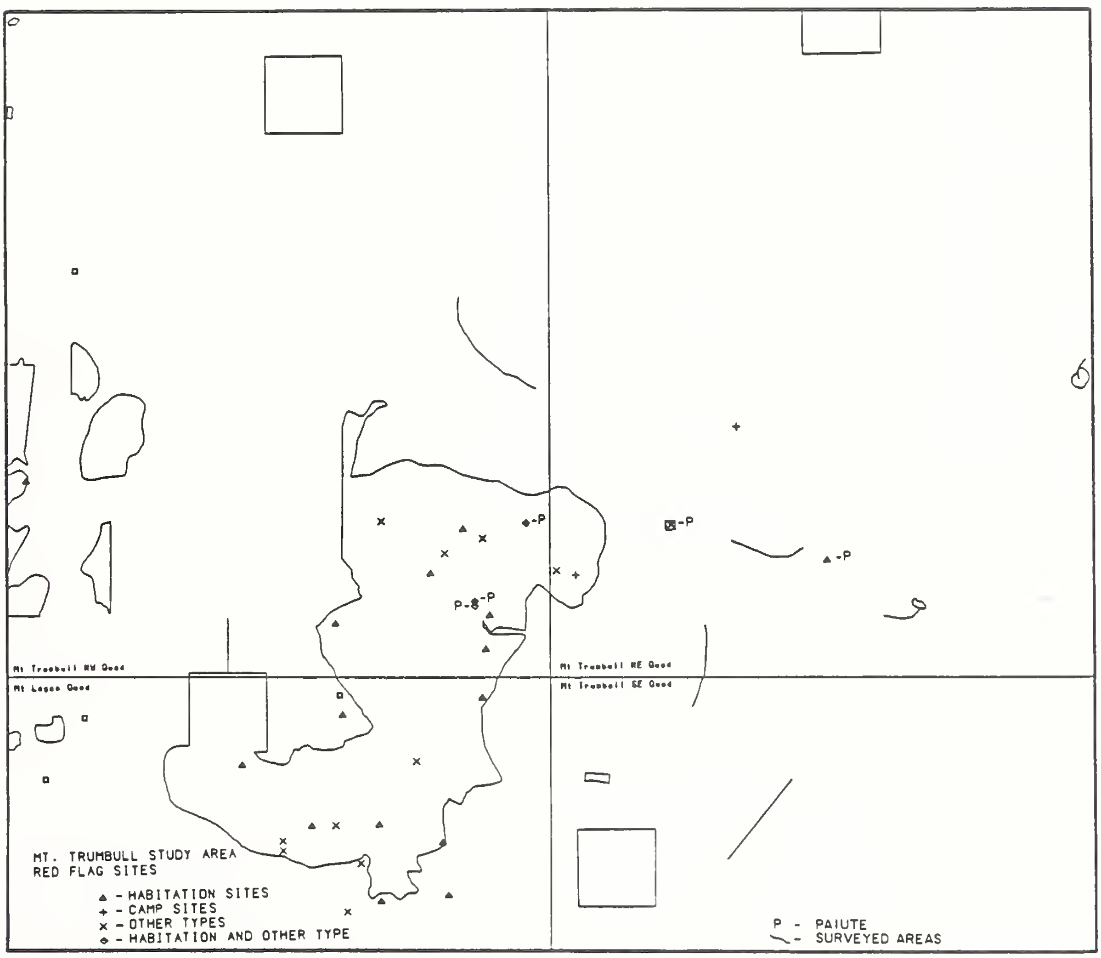


Figure 68. Red Flags, Mount Trumbull.

Table 25. Red Flag Components, Mount Trumbull.

Site #	Site Type* Code	Temporal Affiliation	Code
AZ A:12:45 (BLM)	C	20	Paiute	50
AZ A:12:105 (BLM)	H	9	Anasazi	30
AZ A:12:24 (MNA)	LA	39	Anasazi	20
AZ A:12:77 (MNA)	H	17	Anasazi	26
AZ A:12:77 (MNA)	LA	34	Paiute	50
AZ A:12:80 (MNA)	H	13	Anasazi	24
AZ A:12:39 (BLM)	LA	34	Anasazi	22
AZ A:12:5 (MNA)	LA	32	?	99
AZ A:12:3 (MNA)	LA	34	Anasazi	20
AZ A:12:137 (BLM)	H	17	Paiute	50
AZ A:12:9 (MNA)	H	7	Anasazi	30
AZ A:12:49 (BLM)	LA	33	?	99
AZ A:12:79 (MNA)	C	19	Anasazi	24
AZ A:12:52 (MNA)	H	15	Anasazi	24
AZ A:12:52 (MNA)	LA	34	Paiute	50
AZ A:12:53 (MNA)	H	9	Anasazi	30
AZ A:12:53 (MNA)	LA	34	Paiute	50
AZ A:12:143 (BLM)	H	9	Anasazi	30
AZ A:12:111 (BLM)	H	16	?	99
AZ A:12:87 (BLM)	H	16	Anasazi	20
AZ A:12:33 (MNA)	H	17	Anasazi	30
AZ A:12:134 (BLM)	H	9	Anasazi	20
AZ A:12:117 (BLM)	H	14	Anasazi	20
AZ A:12:57 (MNA)	LA	40	?	99
AZ A:12:67 (MNA)	H	9	Anasazi	26
AZ A:12:47 (BLM)	LA	32	?	99
AZ A:12:68 (MNA)	H	3	Anasazi	30
AZ A:12:65 (MNA)	LA	34	Anasazi	30
AZ A:12:66 (MNA)	H	10	Anasazi	26
AZ A:12:62 (MNA)	LA	32	?	99
AZ A:12:109 (BLM)	LA	34	Anasazi	30
AZ A:12:147 (BLM)	H	9	Anasazi	20
AZ A:12:146 (BLM)	H	14	Anasazi	30
AZ A:12:113 (BLM)	LA	34	Anasazi	30

* H- Habitation; C- Camp; LA- Limited Activity

Table 26. Red Flag Components by Time Period, Mount Trumbull.

	# of components	# of Red Flags	% Red Flags
Paleo-Archaic	1	0	0.0
Formative (Anasazi)	158	23	14.5
NeoArchaic (Paiute)	13	5	38.5
Unknown	47	6	12.8

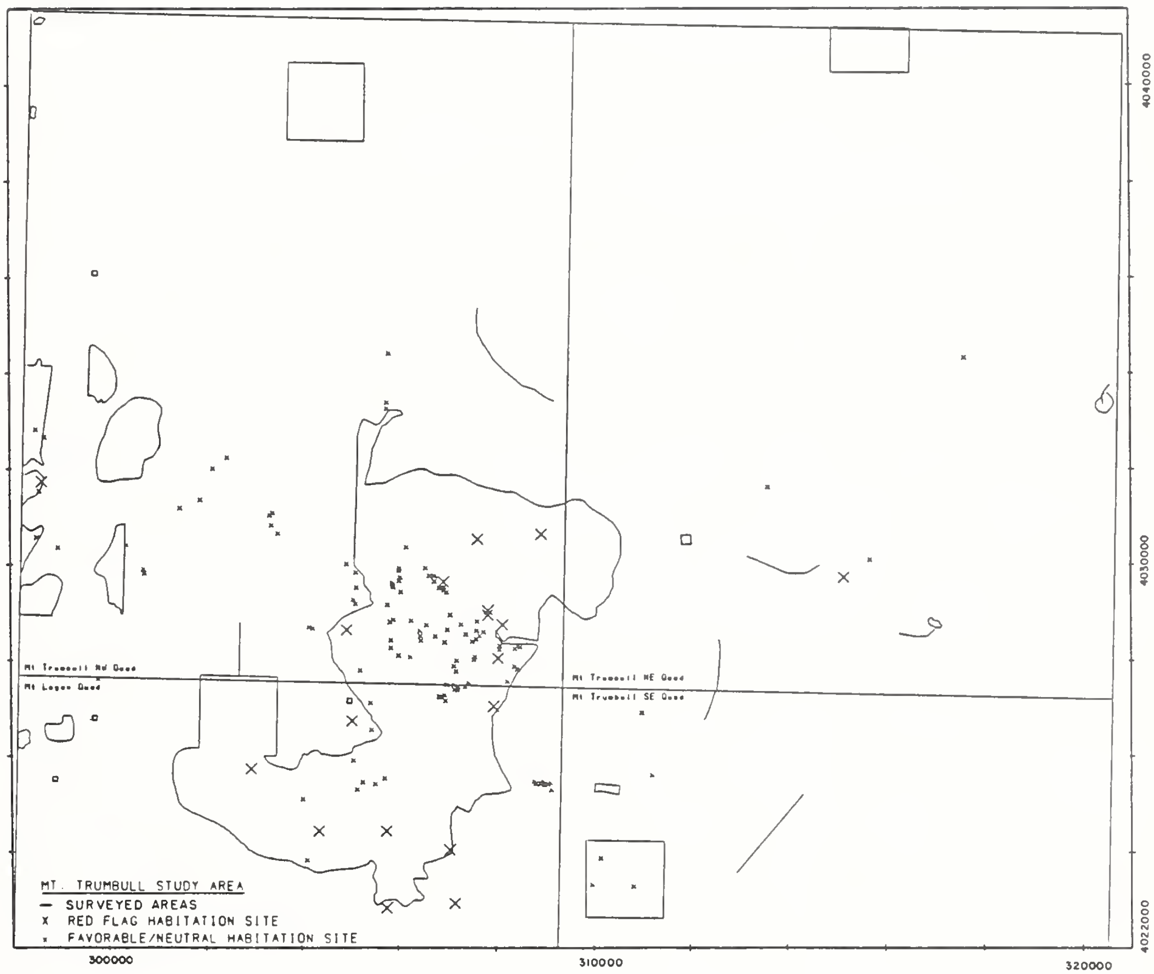


Figure 69. Habitation Components, Mount Trumbull.

A second set of habitation components also poses an intriguing problem. Sites AZ A:12:67 (MNA), 68 (MNA), 117 (BLM), 146 (BLM), and 147 (BLM) are distributed along the southern edge of the modeled area. What distinguishes these components from other habitation components is not so much the site specific setting, but the fact that they are among the largest components in the region, and each one is placed in a relatively isolated setting. Unlike the vast majority of sites located to the north, which are found on the western flank of Mount Trumbull, these larger sites are situated on the southern slopes of Mount Logan. Thus, we have two very different settlement patterns represented; a large number of generally small habitation sites on the western slopes of Mount Trumbull and the small number of spatially isolated large habitation sites on Mount Logan.

Numerous hypotheses could be formulated to account for the situation. One possibility is that most of the inhabitants are living in the Mount Logan sites and are using the Mount Trumbull sites as temporary field houses. Another possibility is that the patterns represent two separate social groups. These groups could either be contemporaneous or separated in time.

Although plausible and worthy of future consideration, these hypotheses are not central to this discussion. The point here is that these patterns were not intuitively obvious. Previous researchers had not noticed this situation (Moffitt and Chang 1978). As an analytic tool, the red flag model and the study of outliers proved to be a very useful approach.

BIG SPRINGS

Big Springs represents an entirely different situation for both managers and archaeologists. Unlike Mount Trumbull, Big Springs cannot be considered a single physiographic unit. The area is clearly tied to a larger region, which includes portions of the Grand Canyon. Any attempt to study this region as if it encompassed an entire cultural pattern is bound to fail. Yet Big Springs is typical of many situations faced by federal archaeologists. Although the area is clearly tied to the Grand Canyon, the canyon itself is under the jurisdiction of another agency and other archaeologists. Forest Service managers want to know how to manage the Big Springs area, not necessarily how the resources relate to other areas.

In other contexts, we have argued that modeling should be restricted to areas that can be related to a distinct cultural system (Altschul and Nagle 1988; Zier et al. 1987). Although this advice is sound, it is often not very practical. To compile the data necessary for modeling the larger Big Springs region, one would have to merge information from three separate computer systems (AZSITE, the Forest Service CRM file, and the Grand Canyon computer file). Such a task is no small undertaking. In evaluating a timber sale or even a series of sales, the effort may not be justifiable.

The selection of Big Springs for the modeling exercise, then, had little to do with theoretical issues concerned with the prehistory of the region. Instead, the analysis was designed to show how modeling could be used in an everyday management context.

Task 1: Data Exploration

The Big Springs study window is located in the west-central portion of the USGS Big Springs 15-minute quadrangle. There are 250 components recorded in this window. Of these, two date to the Archaic period, 206 are Formative in date, four are associated with Neo-Archaic occupations, and 38 cannot be dated. As was the case with Mount Trumbull, the Big Springs data are not currently amenable to the study of temporal dynamics. Most of the sites recorded in the Big Springs study area are habitation sites (174, or 70%). Limited activity sites were the next most frequent site type represented, constituting 22 percent (55) of the database. Temporary camps (16, or 7%) and sites of unknown type (5, or 2%) are present, but rare.

As with Mount Trumbull, the disproportionate number of habitation sites in the Big Springs area may be more reflective of archaeological practices than past cultural activities. Many of the habitation sites are small and may actually represent seasonal use instead of permanent residence. Theoretically, we would expect a higher proportion of limited activity sites to habitation sites than is presently recorded. In short, the database appears skewed, but at present we have no way of measuring or assessing this problem.

Of the three environmental variables, only elevation is correlated with site location (Tables 27, 28, and 29). (Author's Note: 18 sites coded "19" are missing from these tables--their absence does not greatly affect the results.) More sites than expected by chance alone are located between

Table 27. Site Types by Elevation, Big Springs.

	4700-6000	6000-6200	6200-6400	6400-6600	6600-7200	7200-7900	TOTAL
Total Area	5710	5282	5339	4122	8678	6709	35840
Survey Area	891	681	978	1150	1477	7	5184
% Area Surveyed	15.6	12.9	18.3	27.9	17.0	0.1	14.5
% of Elevational Band	16.0	14.8	14.8	11.5	24.2	18.7	100.0
Habitation Sites	7	10	41	40	44	0	142
Base Camps	0	6	2	3	3	0	14
Base or Temporary Camps	2	3	7	1	1	2	16
Limited Activity	0	0	1	0	0	0	1
Other	6	5	15	11	12	5	54
Unknown	1	1	2	1	0	0	5
Total Sites	16	25	68	56	60	7	232

Table 28. Site Types by Slope, Big Springs.

	0-5	5-10	10-20	20-30	30-50	> 50	TOTAL
Total Area	12618	3274	7382	4060	3441	5065	35840
Surveyed Area	2061	531	1405	736	287	164	5184
% Area Surveyed	16.3	16.2	19.0	18.1	8.3	3.2	14.5
% Area in Slope Band	35.2	9.1	20.6	11.3	9.6	14.2	100.0
Habitation Sites	50	15	47	23	5	2	142
Base Camps	4	1	4	3	1	1	14
Base or Temporary Camps	7	2	6	1	0	0	16
Limited Activity	1	0	0	0	0	0	1
Other	24	4	10	10	4	2	54
Unknown	3	0	1	1	0	0	5
Total Sites	89	22	68	38	10	5	232

Table 29. Site Types by Aspect, Big Springs.

	Flat	N	NE	E	SE	S	SW	W	NW	TOTAL
Total Area	5375	4396	1834	1465	549	1793	2634	9699	8195	35840
Surveyed Area	948	483	162	138	48	234	350	1633	1188	5184
% Area Surveyed	17.6	11.0	8.8	9.4	8.7	13.1	13.3	16.8	14.5	14.5
% Area in Aspect	14.9	12.2	5.1	4.0	1.5	5.0	7.3	27.1	22.9	100.0
Habitation Sites	29	8	5	4	2	4	8	43	39	142
Base Camps	1	2	0	0	0	1	1	5	4	14
Base or Temporary Camps	3	0	1	1	0	2	2	3	4	16
Limited Activity	1	0	0	0	0	0	0	0	0	1
Other	10	8	0	2	0	1	2	20	11	54
Unknown	2	0	0	0	0	0	1	1	1	5
Total	46	18	6	7	2	8	14	72	59	232

6,200 and 6,400 ft., and fewer sites than expected are found below 6,000 ft. These findings are in line with most previous general statements about site location in the region (see Chapter 4, this volume).

The fact that neither slope nor aspect is correlated with site location is surprising. We suspect that the lack of correlation with these two variables may be due to the way they were measured. As discussed previously, slope as defined by GIMS is a measure of regional relief and not a site specific attribute. This is also true of aspect. If the region had been divided into smaller sized units, e.g., 25 X 25 m, the results may have been different.

Step 2: Environmental Assessment

The environmental assessment in the Big Springs area is simply a matter of evaluating the coverage of survey in each elevational band. We do not need to assess the spatial relationship between the three variables because only one variable is related to site location. As detailed in Table 27, with the exception of areas above 7,200 ft., all elevational bands have received adequate coverage to have confidence in the survey results. Above 7,200 ft. there has been no survey (although seven sites have been recorded). Thus, this zone is considered neutral in the favorability rules.

Step 3: Favorability Maps

The favorability map for elevation serves as the overall favorability map of site location (Figure 70). This map was created according to the following rules; areas below 6,000 ft. were considered unfavorable for site location and coded -1; areas between 6,200 and 6,400 ft. were considered favorable locations and coded +1; all other areas were defined as neutral locations and coded 0. Using just this single variable, 29 percent (73) of the components were found in favorable locations, 62 percent (156) were located in neutral areas, and less than 10 percent (23) were found in unfavorable settings (Table 30). The fact that most sites were found in neutral settings indicates that the model is relatively weak.

Step 4: Red Flags

By definition all components located below 6,000 ft. are red flags. These sites are listed in Table 31 and displayed in Figures 71 and 72. The red flags are found in two groups; one situated on a ridge between White Pockets Canyon and Side Canyon and the other on a similar ridge between Side

Canyon and Willow Canyon. The vast majority of red flags are small habitations. Most of these components consist of an isolated room or a two- to three-room pueblo, with the largest site containing 6 or 7 rooms.

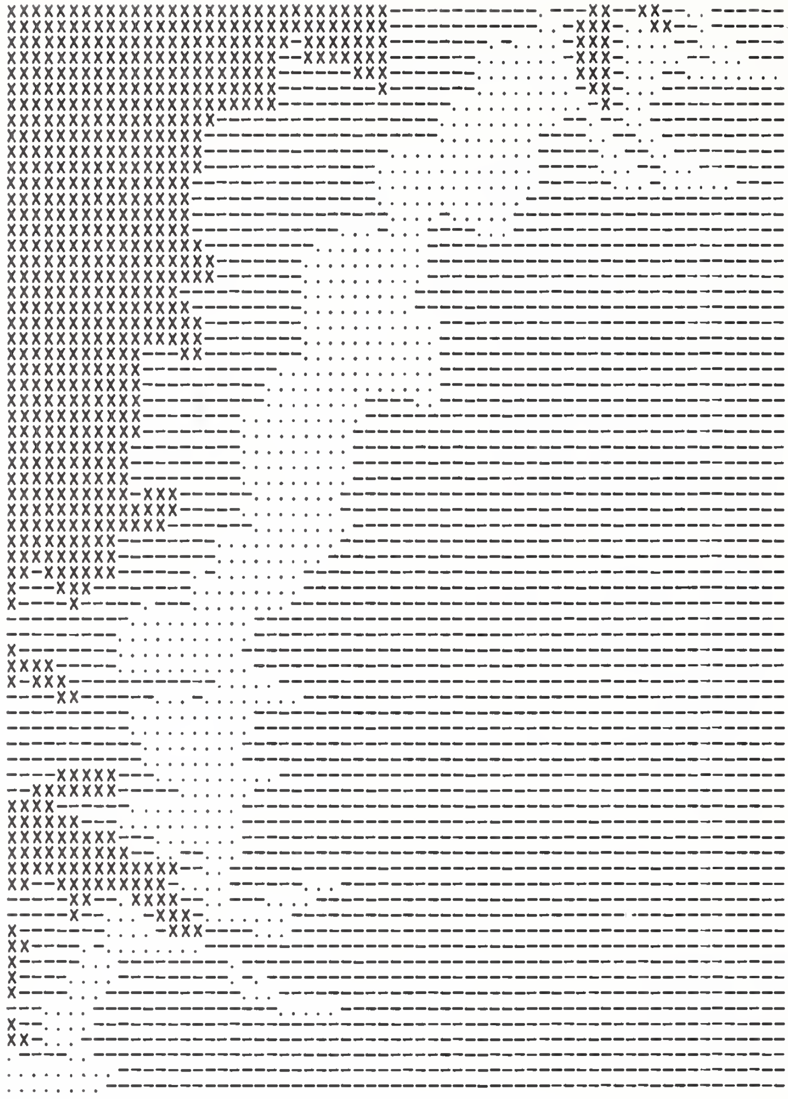
At this point one might ask, what does this model tell us that was not already known? There are two basic answers to this question. First, we have known for some time that sites tend to concentrate in areas of pinyon-juniper and at the transition between the pinyon-juniper and ponderosa forests. There has been a growing realization that the settlement pattern is not that simple. An increasing number of sites have been found below the pinyon-juniper line throughout the region. In time these sites can probably be explained as we learn more about prehistoric subsistence practices, but at present they are still problematic. The red flag approach highlights these sites. We know, for example, that habitation sites below 6,000 ft. are, without exception, small residences. Are these sites smaller, on average, than their counterparts in the pinyon-juniper forests? Are these sites used as seasonal instead of permanent residences? Are these sites fieldhouses, and if so, where are the more permanent habitation sites that the people using the fieldhouses came from? The approach adopted here does not answer these questions, but may allow the investigator to see them more clearly.

The second point the Big Springs model illustrates has to do with the modeling process. The Big Springs model is noteworthy not so much for what it does, but what it does not do. In Big Springs, site location was only correlated with one environmental variable, and that correlation was not overwhelming. To a certain extent, the lack of strong relationships between site location and environmental features may have to do with the manner in which the latter are measured. But this is not the entire answer. The unit used by the GIS (60 X 60 m) was not large enough to mask the relationship entirely. Instead, we believe the model is the best measure of how much we do not know about this region. Site locations simply are not strongly associated with these environmental features. Perhaps they are correlated with other environmental features, such as water sources or soils or perhaps they are a response to cultural factors emanating from elsewhere.

The fact that the model is not very powerful is neither an indication that the model is logically flawed or an indictment of the model-building process. A weak model simply indicates that we do not know very much; that we need to define new variables; that we need to think about different ways that site location, cultural behavior, and the environment could be linked. Instead of being viewed as a waste of time, a manager needs to see an exercise such as the Big Springs model as a necessary first step in the process of understanding and managing cultural resources. Indeed at this time, the Big Springs model indicates that our understanding of this region's cultural resources is poor and that the preservation of these resources, either through avoidance or data recovery, should be a high management priority.

SUMMARY

In the last two chapters, we have examined the general focus of the current BLM and Forest Service CRM programs. We pointed out that by and large both programs are driven by compliance needs, which places the programs in a primarily reactive as opposed to active stance regarding cultural resource management. To encourage more active efforts, we advocated the development of CRM plans, which specify overall goals and specific procedures in managing cultural resources. To develop these CRM plans, we advocated a three-step process; data compilation, data evaluation, and data synthesis. The first two steps are relatively straightforward. Both agencies have procedures to accomplish these tasks, although neither is performing as well as possible. Both the Forest Service and the BLM have invested heavily in computerized databases, which should allow federal archaeologists to compile data quickly and efficiently.



SYMBOL CODE	DESCRIPTION
1	FAVORABLE
4	NEUTRAL
7	UNFAVORABLE
10	VERY UNFAVORABLE

SYMBOL		10	7	4	1	
		#########	XXXXXXXXX	---------	....	
FREQUENCY	0	0	5710	24791	5339	0
PERCENT		0.00%	15.93%	69.17%	14.90%	

Figure 70. Favorability Map, Big Springs.

Table 30. Site Types by Favorability Zones, Big Springs.

DAMES & MOORE G I M S GEOGRAPHIC INFORMATION MANAGEMENT SYSTEM VERSION 86:1

CROSS-TABULATION REPORT -- FREQUENCY OF COMPONENTS WITH FAVORABILITY
ARIZONA STRIP CULTURAL RESOURCES STUDY
DOWN: NUMBER OF ALL COMPONENTS ACROSS: FAVORABILITY

TABULATION	LIMIT	VERY UNFAVORABLE -2.0	UNFAVORABLE -1.0	NEUTRAL 0.0	FAVORABLE 3.0	TOTAL
		0.0%	15.7%	70.1%	14.2%	
NOT SURVEYED	-1.0	0	4814	21471	4359	30644
		0.0%	84.3%	86.6%	81.6%	85.5%
		0.0%	17.7%	64.0%	18.4%	
SURVEYED -- NO SITE	0.0	0	873	3164	909	4946
		0.0%	15.3%	12.8%	17.0%	13.8%
		0.0%	9.6%	62.9%	27.5%	
1 COMPONENT	1.0	0	23	151	66	240
		0.0%	0.4%	0.6%	1.2%	0.7%
		0.0%	0.0%	44.4%	55.6%	
2 COMPONENTS	2.0	0	0	4	5	9
		0.0%	0.0%	0.0%	0.1%	0.0%
		0.0%	0.0%	100.0%	0.0%	
3 COMPONENTS	3.0	0	0	1	0	1
		0.0%	0.0%	0.0%	0.0%	0.0%
		0.0%	15.9%	69.2%	14.9%	
TOTAL		0	5710	24791	5339	35840

SUMMARY		VERY UNFAVORABLE	UNFAVORABLE	NEUTRAL	FAVORABLE
SUMMARY	FREQUENCY	0.0	5710.0	24791.0	5339.0
	SUM	0.0	-4791.0	-21309.0	-4283.0
	MEAN VALUE	0.0	-0.8	-0.9	-0.8
	MINIMUM VALUE	0.0	-1.0	-1.0	-1.0
	MAXIMUM VALUE	0.0	1.0	3.0	2.0
	STANDARD DEVIATION	0.0	0.4	0.4	0.4

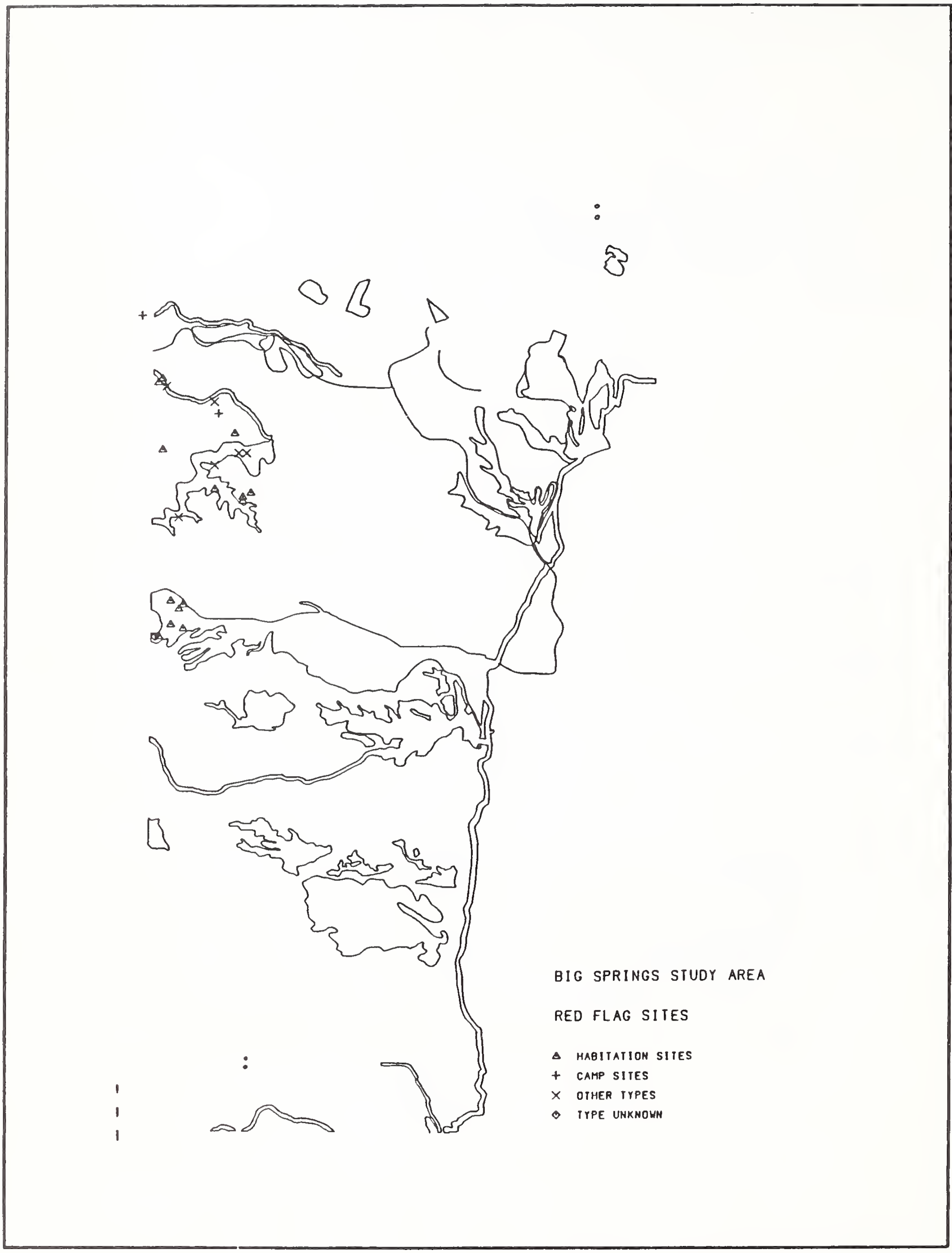


Figure 71. Red Flags, Big Springs.

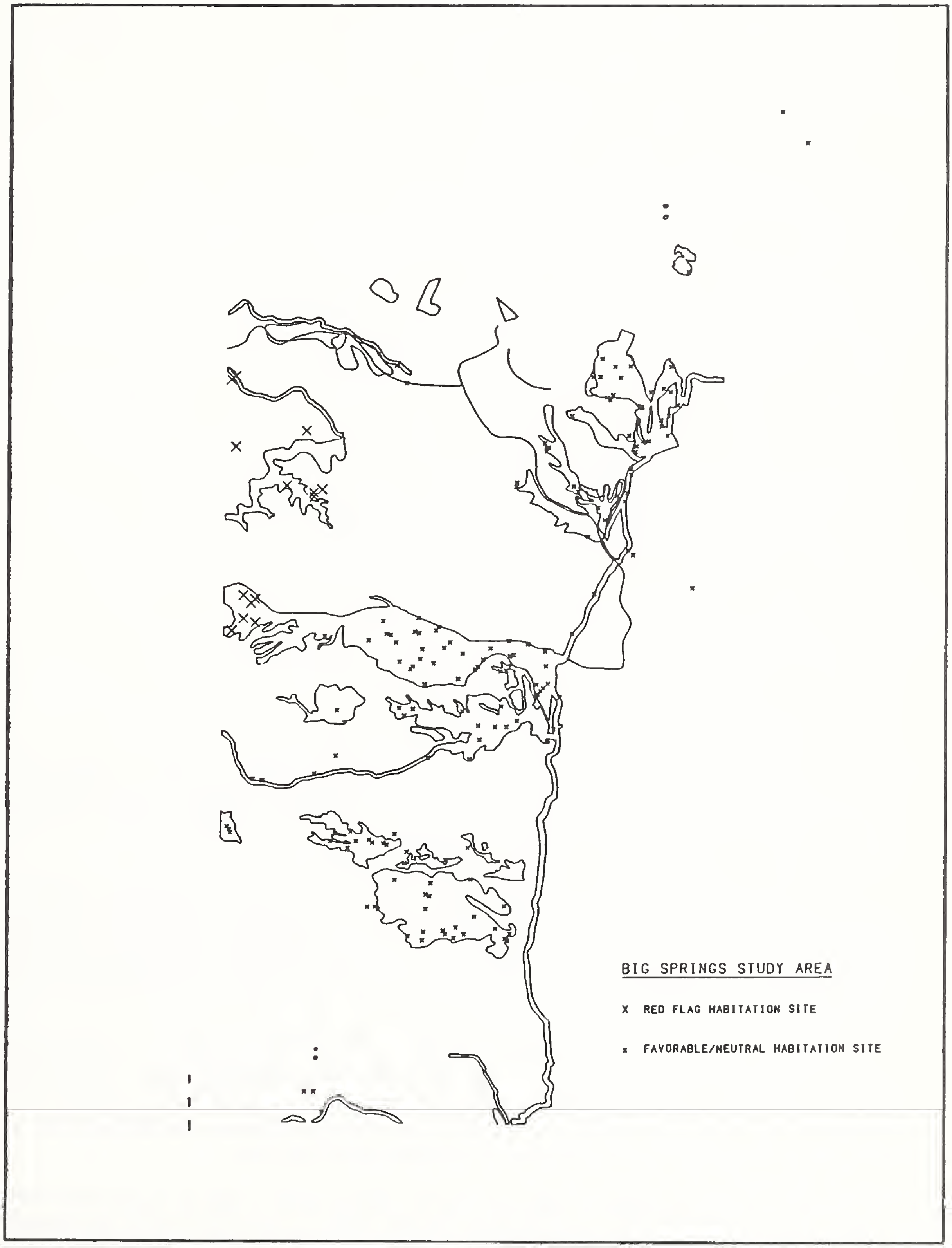


Figure 72. Habitation Components, Big Springs.

Table 31. Big Springs Red Flags Components.

Site #	Site Type[1]	Code	Temporal Affiliation	Code
07010001	H	16	Anasazi	20
2	H	12	Anasazi	20
3	H	16	Anasazi	20
6	H	9	Anasazi	20
7	H	10	Anasazi	20
10	C	16	Anasazi	20
14	H	7	Anasazi	20
281	LA	32	?	99
357	H	7	Late PII	26
358	H	9	Late PII	26
359	?	99	PII	30
387	H	17	PII-PIII	28
388	H	9	PII-PIII	28
754	H	17	Anasazi	20
755	LA	32	?	99
756	LA	32	?	99
757	LA	32	?	99
758	LA	32	?	99
07030325	H	17	PII-PIII	28
326	H	17	PII	30
849	H	17	Late PII	29
B:6:33 (ASM)	LA	32	?	99
B:6:34 (ASM)	C	20	?	99

Note[1] H-Habitation, C- Temporary Camp, LA- Limited Activity

Although the CRM programs are facing challenges with data compilation and data evaluation tasks, these are primarily procedural and mechanical. Specific actions can be taken to meet these challenges without wholesale restructuring of the CRM programs. These actions will be outlined in the next chapter.

The third step, data synthesis, is much more difficult to incorporate into the CRM plans. Although periodic reviews, such as this overview, are an important part of long-range planning, they are not very useful in day-to-day management. But it is precisely at this level that most CRM is done. If data synthesis cannot be incorporated into routine CRM procedures, then it is unlikely that we can ever move beyond a reactive posture.

Data synthesis can take many forms. For example, the agencies could dedicate a certain block of time each year for their archaeologists to integrate that years work into the existing database, with the end product being not only a scholarly document but also a call for directed future research. Some portion of the succeeding year's allocation to CRM, then, could be applied to what the Forest Service terms "non- undertaking" (i.e., not in response to compliance needs) projects.

Although we would encourage any approach that incorporates data synthesis as a part of the CRM programs, we presented one such approach in this chapter. This approach was based on a judgmental assumption about the character of the BLM and Forest Service CRM programs. Although these agencies have earmarked funds for planning and "non-undertaking" projects from time to time, these projects have until now been ad hoc reactions to specific situations. Notable projects in this vein have been the BLM-sponsored Paria Plateau surveys (see Chapter 3), the Mount Trumbull survey (Moffitt and Chang 1978), and the Antelope Cave Project (Janetski 1986). Although we would suspect that when similar situations arise they may also receive agency support, it is fair to conclude that in the foreseeable future both the BLM and the Forest Service's CRM efforts will be primarily compliance-driven. Given this assumption, we wanted to develop an approach that could be made part-and-parcel of compliance procedures.

The modeling approach advocated here is an outgrowth of previous work in site locational studies. No new statistics have been added and no new computer techniques are required. The basic changes are ones of philosophy: instead of looking at what we can predict, we look at what we cannot predict; instead of viewing models as end products, we view them as dynamic analytic tools.

In developing an approach, we were especially cognizant of the importance of keeping it simple. The amount of time allowed to model a timber sale, for example, is minimal. To be successful, we needed techniques that were mechanical and straightforward, and could be accomplished in a relatively short time period (i.e., a few hours). The models developed, termed red flag models, are the result of a four step process.

Step 1: Data Exploration--Data are compiled on the spatial location, temporal affiliation, and functional site type for each recorded archaeological component in a predefined study area. Data on a set of environmental variables are also obtained. The covariation of archaeological and environmental variables is explored through the use of simple statistics.

Step 2: Environmental Assessment--Environmental variables are assessed for adequate coverage of the area and for the degree of spatial independence.

Step 3: Favorability Maps--Favorability rules for environmental variables correlated with site location and statistically independent of one another are devised. Individual favorability maps are produced for each environmental variable and then a composite favorability map is produced.

Step 4: Red Flags--Anomalous site locations are identified and examined. Management plans are forwarded based on a study of overall settlement patterns and red flags.

Red flag models are viewed as analytical tools that can be used in everyday management. The process is not something that is done once, with the product being used as is for a number of years. Our goal was to develop a process so that when archaeologists are informed of a timber sale or mineral lease, for example, they could, within a few hours, have a set of results that would allow them to know where they should expect sites and where they should be particularly careful for sites in unusual or unexpected locations. The red flag approach meets this goal.

CHAPTER 10

SPECIFIC RECOMMENDATIONS

Jeffrey H. Altschul

In Chapter 8 the general structure of the BLM and Forest Service CRM programs was examined. Recommendations were made about the nature of the programs and their general focus. In Chapter 9 we outlined a specific approach that could be incorporated in the CRM programs to help organize and synthesize data. In this chapter we explore other management issues facing the two agencies and offer specific recommendations on procedures and direction.

THREATS TO THE RESOURCE

The activities that threaten cultural resources on federal lands on the Arizona Strip can be divided into two groups-- planned and unplanned (Table 32). Planned threats include any activities that require permits or advance notification. Examples include mining, timbering, and real estate development. In general, planned threats fall into the compliance process. Prior to initiating a project, a compliance survey is conducted, all resources located are assessed for significance, and any adverse effects of the development to significant resources are mitigated through avoidance or data recovery. Clearly, different planned activities pose different threats. Construction projects, whether they be roads or power plants, usually result in the total destruction of resources within the project area. Cattle grazing, in contrast, tends to have minor individual impacts, but the resources are subject to numerous impacts, which cumulatively have the potential for doing great damage. For example, Medford (1972:68) describes a mound site (3WO23) situated in a pasture in Northeast Arkansas. Cattle have made trails across the mound and keep the grass constantly beaten down. This situation has allowed rains to have strong erosive power, resulting in 12 to 18 inches of parts of the mound washing away. Similar studies have shown that this problem is also prevalent in portions of the Southwest (Roney 1977).

Table 32. Threats to Cultural Resources on the Arizona Strip.

Planned	Unplanned
1. Real Estate Development	1. Vandalism
2. Road Construction	2. Natural Processes
3. Mineral Exploration and Extraction	
4. Timbering	
5. Ranching	
6. Recreation	
7. Agriculture	
8. Other Surface Disturbing land uses	

Two types of potential impacts to cultural resources result from planned activities. Direct impacts are those associated with actual developments. For example, the development of a mine will involve the construction of the mine and associated roads and buildings. All areas encompassed by construction activities are viewed as directly impacted by the project. Cultural resources located in these areas that have been determined to be significant will have potential adverse impacts caused by construction mitigated through data recovery.

In addition to direct impacts the development of a mine will also cause indirect impacts. Newly constructed roads will not only bring people to the mine, but will increase accessibility to all land located near the road. Increased access increases the risk of vandalism. It is not assured, however, that any particular site in the region will be vandalized. Thus, cultural resources located near the road are more likely to be adversely impacted by the development of the mine, but there is no guarantee.

To a certain extent, indirect impacts present a far greater problem to land management than direct impacts. The latter must simply be mitigated if they occur to significant resources and cannot be avoided. For the former, however, the issue is not so clear. Do we excavate a site because at some point in the future it may be vandalized? If so, how much of the site must be excavated? Can test excavations suffice for data recovery? How should sites that are not mitigated through data recovery be protected? How wide a corridor must be considered when assessing indirect impacts? What are the costs involved in preparing a data recovery plan, executing the plan, and curating the materials recovered? These are a few of the issues management must address for each project.

Both the BLM Arizona Strip District and the Kaibab National Forest have vigorously supported the consideration of indirect impacts to cultural resources. The two agencies have gone to great lengths to insure that indirect impacts are adequately mitigated in all cases. The concern for future management on the Arizona Strip is not so much that indirect impacts to cultural resources will be ignored, but that the scope of such impacts will be greatly restricted. Archaeologists both in and out of the federal government must work together to demonstrate the importance and degree of disturbance to archaeological sites which was the unintentional result of development. Documenting vandalism, especially vandalism that occurred subsequent to development, would be a valuable first step. This information can easily be retrieved (assuming it is recorded) from both AZSITE and the Forest Service CRM database.

Both agencies' CRM programs deal relatively well with planned threats. After all, the programs were developed with these impacts in mind. The agencies do not deal as well with unplanned threats, which are admittedly less predictable. Thus, it is much more difficult to incorporate actions into management procedures to address them.

There are basically two types of unplanned threats; one is man-made and the other is a function of nature. The first threat is the outright destruction of cultural resources due to casual collection, wanton vandalism, or premeditated theft. As shown in Chapter 7, some form of vandalism has occurred at 69 sites, or about 3 percent of the total number of recorded sites on the Arizona Strip in AZSITE. The problem of vandalism and theft, however, is more pronounced than the numbers indicate. Vandalism occurs at a much higher rate among more significant sites. In general, a site is much more likely to be vandalized if it is large, contains obvious features, and is easily accessible.

The BLM and the Forest Service use a three-pronged attack against vandalism. The first line of defense is public relations and education. Federal archaeologists meet with the public to encourage and support preservation of cultural resources. Such actions are conducted at all levels from grade school to general public meetings. In addition to face-to-face encounters, both agencies issue pamphlets and other materials on cultural resources designed to provide information and to encourage preservation.

The second line of defense against vandalism is to protect the resources in the field. One tactic is to have rangers or other agency personnel monitor significant resources. This approach has recently been implemented by the BLM on the Paria Plateau (Jack 1986). If successful, the program could serve as a model for both agencies. Another popular field action takes the form of fences or some type of minimal protective barrier. These barriers work in some cases, but not in others. Antelope Cave, for example, has been repeatedly fenced and clearly marked as an archaeological site. After each fencing the barrier has been torn down and the site vandalized. In fact, it can be argued that fences tend to draw attention rather than deter it. This is especially true of serious pothunters (i.e., those who set out to vandalize a site).

The third line of defense is law enforcement. Current laws governing cultural resources on federal lands carry fines and possible imprisonment for those convicted. Both the BLM and the Forest Service strongly support law enforcement. Agency archaeologists as well as law enforcement officials are encouraged to attend a week-long course on archaeological resource protection at the Federal Law Enforcement Training Center. In the field, each case of suspected vandalism is researched and documented. Although a concerted effort is placed on law enforcement, the decision to prosecute any single case is not made by the BLM or the Forest Service, but by the United States Attorney. In general, the U. S. Attorney is reticent to try a case unless there is a reasonably strong chance of obtaining a conviction (John Hanson, personal communication, 1987). Thus, many cases of suspected vandalism go untried, not because of lack of desire, but due to the weakness of the evidence.

The second type of unplanned threat derives from the natural processes of environmental change. Erosion, alluviation, and weathering are constantly reshaping the landscape. Cultural resources are continually being buried, exposed, and displaced. Although we cannot hope to, nor should we, stop these processes, we can monitor and in some cases mitigate their impacts on cultural resources. A critical part of recording a site is assessing the amount of natural disturbance that has already occurred and the potential for future disturbance. It would be ideal to re-evaluate all sites on a periodic basis and then mitigate the effects of natural processes on those in danger of being lost from the archaeological record. Such a program, if implemented on a large scale, is well beyond the means of the current CRM programs.

A more modest proposal would be for each agency to specify a set of highly significant sites, the loss of which would be a tremendous blow to the cultural heritage of the region, and to institute a monitoring program for these resources. If any site on this list was in danger of being irreparably damaged either due to natural forces or vandalism, mitigative procedures would ensue. One program that has worked very well on the Arizona Strip to accomplish these objectives is the use of volunteers to monitor historical and archaeological sites. Use of some of these volunteers will soon be formalized as part of the statewide Site Steward Program. Site stewardship not only fulfills an important need, but also provides an opportunity for the public to get involved in historic preservation.

PROCEDURAL RECOMMENDATIONS

Specific recommendations are offered for each of the three task divisions discussed in Chapter 8. These divisions are data recording, data evaluation, and data synthesis.

Data Recording

Of the 2,687 recorded components on the Arizona Strip, 1,511 (56.2%) are classified as some type of habitation site, while only 1,176 (43.7%) have been assigned to unknown or limited activities. The proportion of habitation sites seems unusually high. In surrounding areas, such as the Great Basin and the Mojave and Sonoran Deserts, the proportions are generally reversed, with the numbers of limited activity sites to habitation sites being at least 2:1 and often higher.

There are three possible explanations for the high proportion of habitation sites recorded on the Arizona Strip. First, the ratio could be an accurate reflection of cultural behavior. This explanation seems unlikely given the settlement/subsistence practices used by hunter-gatherers and horticulturalists in general and by the ethnographic accounts of peoples living on the Arizona Strip in particular. Both the mobile Paiutes and the more sedentary Pueblo groups used a variety of transient special-use camps, which greatly outnumbered their habitation sites in any given year (e.g., Kelly 1934; Ward 1978).

A second explanation is that the high proportion of habitation sites reflects a systematic bias on the part of archaeologists to record larger, more substantial sites to the detriment of small, ephemeral sites. There is merit in this argument, especially for work done prior to the renewed theoretical interest in settlement patterns in the early 1970s (e.g., Thomas 1973) and before the adoption of current survey standards used in cultural resource management. Although a bias toward recording larger habitation sites exists, the degree to which these practices have affected the overall databases is unknown. In areas such as the Paria Plateau and the Virgin River drainage, which were the focus of archaeological attention prior to 1970, this bias is probably pronounced. In areas where most of the sites have been recorded in the last decade, such as portions of the North Kaibab District of the Kaibab National Forest or the BLM Vermillion Resource Area, we would not expect recording bias to be significant. Examining the results from Chapter 7 shows that the proportion of habitation sites to limited activity sites for the Shivwitz Resource Area is 1:2.3, which is about what we would expect. The ratio for the North Kaibab Ranger District, however, is 2.5:1.

Accounting for the high proportion of habitation sites on the North Kaibab Ranger District brings us to the third explanation; the manner in which sites are found. Both the Forest Service and the BLM require essentially the same survey techniques. These techniques, which must be used by federal archaeologists and private institutions under contract, demand relatively narrow spacing between surveyors (20 m for the Forest Service and 30 m for the BLM) and limit all examination to the surface. These practices should result in sites of all types being encountered during survey. Why, then, are a disproportionate number of habitation sites represented on the North Kaibab Ranger District?

We believe a large part of the answer results from limiting examination to the surface. In many forested contexts, the surface is obscured. Unless surface exposures are created, the probability of site discovery in these areas is quite low (see Nance and Ball 1986). This general observation appears to hold for the North Kaibab Ranger District. An impressionistic assessment of the site files indicates that sites are found along exposures (e.g., road cuts) and in open areas (e.g., meadows), and are generally absent from heavily forested areas.

One solution would be to conduct shovel tests. This approach would entail excavating a small unit (e.g., 30 X 30 X 30 cm) and then screening the fill, in areas with obscured ground surface. These tests would have to be excavated systematically along the transects, with the interval between tests not exceeding 20 or 30 m. This approach would certainly resolve the issue of varying site discovery probabilities, but it would also come at a relatively high cost. The amount of survey conducted per person per day would drop dramatically. Without increases in manpower fewer acres would be surveyed; an option that is simply not possible under current federal guidelines.

There are those who believe that the trade-off between spatial coverage for increased intensity is not worth it. They contend that the greater the area actually surveyed, the larger the number of discovered sites, especially significant sites. As long as significance is equated with size and complexity, there is little doubt that the position favoring greater spatial coverage is correct. We are not convinced that this equation is valid. To understand any type of settlement system, all parts of that system must be represented. In archaeology, we start at a disadvantage because the archaeological record is only a sample, and a biased one at that, of any prehistoric settlement system. To confound our understanding by further biasing the analytical record is not in the best interest of the discipline or the public. In short, significance must relate to potential scientific return, and at present on the Arizona Strip the return on small sites is just as great as it is on large ones.

Although the simplest solution to this impasse would be for the Forest Service to increase its manpower for survey, such an occurrence does not seem likely in the near future. As an alternative, we suggest that the Forest Service initiate an experimental program to test whether subsurface testing would greatly affect the number of small sites recorded. For the next several years, the surveys in forested areas on the North Kaibab Ranger District could be split into two equal groups. In one group current survey procedures would by conducted, while in the other these techniques would be supplemented by a subsurface testing component. At the end of each year, results of the two programs could be compared and an evaluation made about the efficacy of each approach. Over a number of years, then, enough data would be collected to determine whether subsurface testing does indeed increase the number of sites found per acre as well as redress the skewness in the database. The Forest Service would also know at what costs these improvements come.

Once a site is found, it needs to be recorded. Site recording involves making observations about the physical characteristics of the site, the environmental setting, and the cultural assemblage. The need for accurate observation is paramount; once recorded, the information is assumed to be correct.

Perhaps the most troubling types of recording errors are those that involve simple field observations. Sites may be misplotted on maps or the surrounding vegetation may be misidentified. Without revisiting the site, errors of observation go largely undetected. Both the BLM and the Forest Service recognize the potential problems that can occur in field recording and have taken steps to minimize this source of error. Agency archaeologists are required to have degrees in a field related to cultural resource management and adequate field experience. Only professional archaeologists can record and evaluate sites. Paraprofessionals are used to find sites, but only after they have completed training on archaeological field techniques and cultural resource management.

In addition to making observations about a site's physical characteristics and the environmental setting, site recording involves obtaining information on the artifact assemblage. Data on pottery types, projectile point styles, and historic artifacts are critical to determining when a site was occupied. In obtaining this information, the agencies have taken decidedly different paths. The Forest Service collects a grab-bag sample of diagnostic artifacts, which are then cleaned, analyzed, and stored at the Forest headquarters. This approach not only allows the analysis to be conducted indoors, but also grants others the opportunity to check the identification.

The BLM has adopted a strict nondisturbance/noncollection strategy. All observations about a site are recorded in the field. This approach leaves the site undisturbed; thereby maximizing future research potential. Noncollection surveys also circumvent the problem of curation, which for an agency that administers over two million acres on the Arizona Strip would be no small task.

The basic problem with the noncollection approach to survey is that we are often left with knowing very little about a site. Even under good weather conditions, field identification of artifacts is a difficult task. Without proper reference material, clean artifacts, and analytic tools, identifications are often tenuous or much cruder than they would be in a laboratory (e.g., a sherd might be identified simply as

Anasazi as opposed to the more specific Pueblo II or may be misidentified as Moapa ware instead of North Creek Gray ware, which could introduce an error in temporal placement). Perhaps the most troubling aspect of the noncollection approach is that the artifact identifications are not readily verifiable.

We encourage the BLM to re-examine its noncollection policy. We recognize that noncollection surveys are less expensive. Artifacts do not have to be cleaned, catalogued, and curated. But if the experience of the North Kaibab Ranger District is any example, it is clear that the judicious use of surface collections can result in a more complete assessment of a site's artifact assemblage, without incurring large analytic or curation costs.

Data Evaluation

After a site is recorded, the information is coded and placed in a computerized database. Coding errors are common in all data processing environments. The BLM and the Forest Service recognize this fact and have taken appropriate steps to circumvent these potential errors. The Forest Service only allows USFS archaeologists to enter data. A hard copy of the site data is then produced and each record is manually checked. The BLM also places a major emphasis on quality control. Only professional archaeologists are allowed to fill out site forms, which are then sent to the Arizona State Museum for placement in the AZSITE system. When the coding is completed, BLM archaeologists check the AZSITE data for errors.

The practices used by the agencies today insure an accurate and reliable database. Unfortunately, both agencies are also saddled with past practices, which do not meet current standards. For the Forest Service, the problem has been with site locational data. For the BLM, site forms completed by archaeologists in and out of the BLM prior to 1984 were not always completely filled out and data on attributes such as features and artifact types were not always accurately recorded.

The variable quality of some of the "old" site data greatly limits the utility of AZSITE and the USFS computer database for either research or management purposes. For example, a substantial portion of our effort during this project was devoted to re-analyzing every site form and classifying components to consistent site type and temporal categories. Certainly on a project of this size, which covers a large area and the work of many distinct individuals and institutions, there was no reason to expect that different investigators would view similar phenomenon in the same way. We found, however, that as long as adequate site descriptions existed, we could reclassify sites into our system with relative ease. But we could not deal with sites that were inadequately recorded, and in the end had to ignore a substantial number of sites in our examination of the database.

Both agencies recognize the deficiencies in their databases and have taken steps to correct them. The Forest Service is in the process of entering all missing UTMs. The BLM is updating site forms on an ongoing basis. Once these corrections have been made, the databases will prove to be invaluable to archaeologists and managers alike.

Both the Forest Service and the BLM have moved into the computer age, yet in many cases their management of information has not. The agencies have invested heavily in hardware and software that ideally should provide more information into the hands of those making decisions, but often the information does not reach them. The problem faced by both agencies is a common one. Mastering computer technology requires substantial investments of time and proper support. Both the Forest Service and the BLM have computer experts on staff who support the various hardware and software utilized by the agencies. Individuals can answer questions about the system, but it is not practical to have them conduct detailed analyses for different departments within the agency.

The success of the Forest Service and the BLM-CRM programs, then, will become increasingly dependent on the efficient use of these capabilities by Forest and Resource Area archaeologists. The agencies have obtained the technology and provided the support. It is now up to the archaeologists to learn those programs needed to manage the resources. For example, both agencies have the capabilities to conduct the modeling procedures outlined in the previous chapter, but the archaeological staffs at the present time do not have the requisite knowledge to pursue them. If the agencies rely on personnel in Denver or Albuquerque to conduct these techniques then this modeling program, or any other computer-aided program, will never reach its potential.

Each agency needs to evaluate the computer skills required at the District or Forest level. Training programs to achieve these levels of computer expertise should then be developed. This process needs to be ongoing, for it is clear that although the computer may make managing information easier, managing the computer is only going to become more difficult.

Looking beyond the BLM and the Forest Service, it is worthwhile to point out overall database management constraints that pertain to research on the entire Arizona Strip. At present there are three major computerized databases in use on the Strip. The BLM, along with a variety of other institutions and federal agencies, utilizes AZSITE, the Forest Service employs its own CRM computerized database, and the Grand Canyon National Park is in the process of transforming their data from the SARG format housed on a mainframe computer to Dbase III+ files to reside on personal computers (Janet Balsom, personal communication, 1987). These databases are not easily made compatible. As part of this project, we developed a series of computer programs that merge AZSITE and Forest Service data (Appendix 3). The next step in this process would be to amend these programs to include data from the National Park Service.

We would certainly encourage the development of this link. We would also caution other researchers about uncritically using the data. This problem is especially acute with that data on AZSITE. Not only have the data generally not been checked, but due to the extensive use of alphanumeric fields, it is often difficult to program using these data. For example, one of the variables we were interested in was the source of site deterioration. In the AZSITE manual there are eight "legal" values listed for this variable; fire, flooding, grazing, mining, off-road (vehicular disturbance), range-improve (range improvement), timbering, and vandalism. Of the 544 sites that have a source of deterioration noted, 223 are coded as "ero" and 65 are coded as "con". After seeing these "errors", the Arizona State Museum was contacted and we were notified that there are really 11 legal values for this variable; the other three being "ero" for erosion, "con" for construction, and "unknown." If you did not know these codes existed (and in practice there is little reason for one to suspect that they do) and only requested information for the legal values listed in the manual, the result would be information on only a sample of sites of deteriorating condition. Even if you know the codes exist, however, without knowing what "ero" and "con" refer to, it is impossible to use these data. When analyzing regions on the order of the Arizona Strip, this problem can be sizable. In general, we would suggest previewing the data prior to extensive programming.

The ability to manage information is a precursor to data synthesis. In the previous chapter, we outlined an approach that includes spatial modeling as an integral component of CRM procedures. We will not reiterate the approach here. We do, however, strongly recommend that some form of data synthesis be made a routine part of day-to-day management.

One of the advantages of using the red flag modeling approach is that sites and areas of unusual interest are highlighted. To complete the modeling process, these areas would need to be systematically investigated. In so doing we would come to understand the rationale behind locating sites in these areas, thereby increasing our knowledge about prehistory. In most cases, such surveys would not be conducted out of compliance needs. These surveys instead would be done to enhance the agencies' understanding and management of cultural resources.

Why should either the BLM or the Forest Service support such studies? The pursuit of these types of projects is perhaps the only means by which the agencies can shift their CRM programs from simply reacting to the development of other resources to actively engaging in historic preservation. They provide the balance needed to place the results of compliance work in their proper perspective. Whether these projects involve survey or excavation, they are needed to fully meet both the spirit and the letter of the law.

Though it is easy to support research in principle it is another matter to find actual funds to support it. We recognize this problem. We suggest, however, that there are mechanisms of support that are compatible with the nature and funding levels of current CRM programs. One approach is to support field schools. In this vein, the BLM's support of Brigham Young University's field school at Antelope Cave and Yellowstone Mesa could serve as an excellent example. The BLM provides logistical and limited financial support in return for active, ongoing research of resources under the agency's administration. Both the BLM and the Forest Service should encourage other universities and institutions to establish long-term research interests on the Arizona Strip. In lieu of funds, the agencies could support these endeavors by providing equipment and facilities that are already owned, such as computer hardware and software (including GIS), housing, and the expertise of their inhouse staffs.

As to the last point, the BLM and the Forest Service need to take full advantage of their own in-house capabilities. Both agencies have successfully filled their internal archaeological positions with well qualified individuals. No one knows the resources or the archaeology of the Arizona Strip better than these people. Within both agencies, the Resource Area and Forest Archaeologists have identified sites to be tested, areas to be surveyed, and issues to be studied. Providing these individuals with both financial support and time to pursue these research topics is perhaps the best way to further our understanding of the prehistory and history of the Arizona Strip.

USE CATEGORIES

In the previous sections, we have discussed issues involved in day-to-day management of cultural resources. The nature of the various activities that threaten cultural resources have been outlined, and some of the actions that could circumvent potential impacts have been discussed. Specific recommendations have been offerred, which we believe would strengthen each agency's ability to find and interpret sites as well as manage and synthesize existing data. What we have not done to this point is examine the position of the CRM programs in the overall agency. It is to this task that we now turn.

Under the existing legal framework, cultural resources are all evaluated by a single standard; their potential eligibility for inclusion in the National Register of Historic Places. A site is either considered eligible or it is not. If not, the site usually does not warrant protection from potential adverse impacts.

The last statement is qualified because a site deemed ineligible for the National Register may be protected by an agency because it possesses certain intrinsic qualities, such as cultural or public values. While possible, practically speaking there is no doubt that the Section 106 process by which the National Register status of a site is determined is the mechanism that drives much of the CRM process. But the National Register in-and-of itself is not a management tool. Determining that a site is potentially eligible for the National Register only tells the agency that prior to development, potential adverse impacts to the site should be mitigated. It does not tell the agency what to do with the site in the absence of threatening activities.

Both the BLM and the Forest Service are multipurpose land managing agencies. The 'business' of these agencies is a combination of developing resources (e.g., timber, minerals, etc.), protecting resources, and enhancing areas (e.g., recreational facilities) within a context of land stewardship. In pursuing one objective, the agency often comes in conflict with another. For example, the development of a parcel for timbering may be detrimental to the regional objective of enhancing wildlife habitats. Reconciling these conflicts goes to the heart of resource management. The principles guiding management decisions were best expressed long ago by Gifford Pinchot, the founder of the Forest Service. "All land is to be devoted to its most productive use for the permanent good of the whole people ... where conflicting interests must be reconciled the question will always be decided from the standpoint of the greatest good of the greatest numbers in the long run" (Keyser 1985:1).

In the past on the Arizona Strip, neither the BLM nor the Forest Service integrated considerations of cultural resources into the planning process as well as agency archaeologists or managers would have liked. In part this problem is due to the relative "newness" of the legal framework protecting cultural resources. Both the BLM and the Forest Service had long-established management procedures in place prior to the development of their cultural resource programs. Cultural resources were considered in the planning efforts of each agency, but were not made an integral part of the process to the same extent as other resources. Considerations of cultural resources focused primarily on mitigating impacts resulting from managing other resources, rather than focusing on ways in which various cultural resources might be used or managed. As we discussed in Chapter 8, cultural resource management has generally been more a reactive than an active component of the planning process.

Both federal land managers and archaeologists on the Arizona Strip have made a commitment to change this situation; to bring cultural resources in line with overall agency missions and integrated into the planning process. The first step in this direction is to move beyond questions of National Register status and into the area of use categories.

Both the BLM and the Forest Service categorize cultural resources by their potential uses. These categories are outlined in Table 33. The definitions used in the table are from the Arizona BLM Manual Supplement (8111), with the Forest Service terms that most closely fit these definitions found in the last column.

Use categories allow BLM and Forest Service archaeologists to classify resources by potential management actions. These categories allow archaeologists to move beyond the dichotomous significant/nonsignificant label of the National Register and to place sites into classes that have meaning to the agency's planning process.

The Conservation for Future Use and Socio-cultural Use categories are perhaps the most critical to land managers. These categories refer to sites that should not only be avoided, but also afforded long-term protection. The first category is assigned to only the rarest and the most spectacular archaeological sites or historic sites associated with particular events of singular regional importance. Simply because a site meets the above criteria, however, will not automatically mean that it will be placed in this category. Alternative management uses for the land must also be considered. On the Arizona Strip, there are clearly sites in our opinion that meet the above criteria. For example, some of the large multi-component sites on Mount Trumbull discussed in Chapter 9 would appear to qualify for this category as would such historic sites as Brow Monument.

Resources affiliated with known groups also deserve protection. Many such resources will not be archaeological sites or historic buildings, but instead will be natural features. For example, buttes considered sacred by the Paiutes would fall under this designation. During the scoping process for land use planning, all groups including Native Americans are encouraged to come forward with information or concerns that pertain to a proposed undertaking. Unfortunately, these public notices and forums rarely elicit information on Native American concerns. Moreover, sacred site evaluations are usually not part of a CRM survey. Consequently, it is often only during the development phase of a project that objections are raised; by which time it is usually too late to avoid impacts to the resources in question. One solution that has been used with success by some National Forests and BLM Districts is to conduct a comprehensive ethnographic study of Native American place names. For instance, the San Bernardino National Forest was the subject of one such study based on ethnographic interviews and archival research (Bean and Vane 1981). The study resulted in a map of sacred place names that the Forest uses in project planning.

The two categories, Public Use and Management Use, refer to types of uses that will modify or even destroy the resource. Management or Experimental Use refers to studies in which an archaeological or historic resource is the subject of a controlled experiment. These experiments are designed to examine the effects of specific man-induced or natural agents that are suspected of adversely impacting the integrity of all or a class of resources. Examples of controlled experiments include plowing fields to study the movement of surface artifacts or capping a site with sterile soil and then at some future date conducting excavation to determine the effects of this action on rates of artifact breakage and the integrity of organic remains.

The use of sites in controlled experiments basically transforms their use from what they can tell us about prehistory or history to what they can tell us about processes of deterioration, archaeological techniques, and effectiveness of protection procedures. These studies are necessary and should be encouraged. Selection of resources to be subjects of tests, however, needs to be judicious. In general, sites should be selected that are representative of a large class of sites in a common situation. For the Kaibab National Forest, the effects of timbering operations should be studied by selecting a small number of artifact scatters, temporary camps, base camps, and small structural sites, conducting detailed recording of surface and subsurface conditions, monitoring the impacts caused by timbering activities, and then comparing site condition after the timbering operation with its prior condition. The Kaibab National Forest actually tried to conduct such an experiment with the El Paso Timber Sale (John Hanson, personal communciation, 1987). Unfortunately, after the study was set up, the timber sale was cancelled.

Similar types of experiments could be proposed for impacts common on BLM land. One example is the effects of cattle grazing on sites. In this case, sites could be selected from a variety of grazing situations, recorded in detail, monitored while cattle graze over them, and then restudied.

The key to successful controlled experiments is that they be well planned. It is doubtful that during an initial site evaluation one could envision how a particular resource could fit into an experimental design. The whole process should be oriented from the opposite direction. Instead of finding a resource and then designing an experiment, one should first evaluate the types of impacts and the affected types of sites and then and only then select a sample of appropriate sites. The management use category, therefore, must remain an ad hoc value assigned to a site for a particular reason.

Table 33: Use Categories.

BLM	Definition (From Arizona BLM <u>Supplement 8111 Manual</u>)	Forest Service Term
Current Scientific Use	Cultural property is the subject of an ongoing scientific or historical study or project at the time of evaluation.	none
Potential Scientific Use	Cultural property is presently eligible for consideration as the subject of scientific or historical study utilizing research techniques currently available, including study that would result in its physical alteration, and that it need not be conserved in the face of an appropriate research or mitigation proposal.	Scientific Study
Conservation for Future Use	Because of the scarcity of similar cultural properties, a research potential that surpasses the current state of the art, singular historic importance or architectural interest, its value as an outstanding representative of a particular property class, or comparable reasons, a cultural property is not presently eligible for consideration as the subject of scientific or historical study or other use, which would result in its physical alteration, and that it is worthy of segregation from other land or resource uses that would threaten the maintenance of its present condition, and that it will remain in this use category until specific provisions for its use are met in the future.	Long-term Preservation Restoration, Continual, or Adaptive Use
Socio-Cultural Use	Cultural resource is perceived by a specified social and/or cultural group as having attributes, which contribute to maintaining the heritage or existence of that group, and is to be managed in a way that takes those attributes into account, as applicable.	Ethnic Value -Secular Ethnic Value -Religious
Public Use	Cultural property is eligible for consideration as an interpretive exhibit-in-place, a subject of supervised participation in scientific or historical study, or related educational and recreational uses by members of the general public.	For Interpretation For Development Moderate Development Display (Site Museum) Interpretive Trails/ Sign(s) Map/Brochure Alternative Use (Books, films, etc.)

Management Use	Cultural property is eligible for controlled experimental study that would result in its physical alteration, to be conducted for purposes of obtaining specific information leading to a better understanding of the kinds and rates of natural or human-caused deterioration, the effectiveness of protection measures and similar lines of inquiry which would ultimately aid in the management of cultural properties.	Experimental
Discharged Use	Cultural property previously qualified for assignment to any of the categories defined above but that it no longer possesses the qualifying characteristics for that use or for assignment to an alternative use, or that records pertaining to it represent its only remaining importance, and therefore its location no longer presents a management constraint for competing land uses.	Removed from Management Consideration

The Public Use or Interpretive category is perhaps the most important for meeting the spirit of CRM legislation. Sites in this category are eligible for in-place exhibits, supervised excavations, or other related educational activities. Although many sites are potential candidates for interpretive use, the BLM and Forest Service would be best served by concentrating their efforts on a few. In-place preservation is expensive in time and funds. The resource must be prepared, which might include construction of a visitor center, parking, or support buildings, and once prepared, the site must be maintained on a continuous basis. Previous overviews for the BLM in Arizona have advocated the development of archaeological "parks" in areas where a diversity of site types are represented (McGuire and Schiffer 1982; Stone 1986). The term "park" is somewhat of a misnomer, for neither the BLM nor the Forest Service manage parks per se as part of the agency's mission. A better term for this concept would be archaeological or historic "management areas." Such areas would include a variety of "developed" resources in the form of restored historic buildings or stabilized prehistoric ruins. This idea is sound and certainly a number of candidates for such archaeological management areas exist, particularly on the Paria Plateau, Mount Trumbull, and the Virgin River, while historic management areas could be envisioned around Jacob Lake, Fredonia, and Lee's Ferry.

Although interpretive management areas are an exciting concept, by-and-large the majority of interpretive efforts by the Forest Service and the BLM have been and will continue to be confined to less ambitious projects. Examples of interpretive projects that the agencies routinely engage in include interpretive trails, historical markers, and site brochures and maps. This type of activity is generally best conducted on standing historic structures that are structurally sound. Visitors are then able to view the resource unaided. Archaeological sites are more difficult to utilize in this fashion. For archaeological sites, unless a substantial amount of excavation and reconstruction have been conducted, visitors have a difficult time visualizing the nature of the remains. A notable exception are concentrations of rock art, which can often be stabilized and open to the public without undue expense.

Of all the use categories, the ones that are likely to cause the most controversy are the Discharged Use and Scientific (both potential and current) categories. In many regions, sites qualifying for the former category would include small artifact scatters and highly disturbed sites. Given our present knowledge of Arizona Strip culture history, one could make the argument that virtually any intact site is important. No such site, therefore, should be placed in the discharged use category; instead, at the very least, all such sites should be designated "scientific use."

This blanket statement, although easy for archaeologists to make, skirts the much more difficult issue of setting priorities. For the National Register, a site is either eligible or it is not. In practice, however, sites differ in their research potential. Instead of an all-or-nothing proposition, a site's research worth can be placed on a scale, ranging from no potential to extreme importance. All such scales are, by design, subjective. They reflect the biases and personal interests of the individual who created them. This fact does not negate the utility of such scales. In the end, it is the federal archaeologist who must determine a site's research potential and weigh this potential against alternative management uses.

It is in the context of management decisions that the notion of differing research potential becomes important. If a certain action will adversely impact a site, a manager needs to know not only the cost of mitigating effects to the site, but also the potential return to the scientific community and the public at large of the archaeological excavation or historic restoration. The red flag modeling approach described in Chapter 9 provides one context from which to make these types of decisions. For example, assume that a decision must be made between developing two parcels of land on Mount Trumbull. One contains a red flag site and one contains a non-red flag site. If the costs of development are equal, it would be preferable to develop the red flag parcel because the site is likely to provide more insight into the prehistory of the region; that is, in the management decision equation the archaeological return for the red flag parcel makes this area the best overall choice.

Both agencies are committed to making cultural resource management an integral part of the planning process. To do so requires moving beyond statements of significance to establishing a framework that evaluates cultural resources within the context of decisions about multiple resources and various management actions. Use categories provide the labels, but the framework must be developed by the historians and the archaeologists working on the Arizona Strip. Modeling provides one such framework, but there are others, such as regional research designs. At this point choosing which framework to use is less important than making sure some framework is chosen.

SUMMARY OF RECOMMENDATIONS

Recommendations concerning the managment of cultural resources by both the Forest Service and the BLM have been offered throughout this chapter. Stated concisely, we recommend the following.

1. The establishment of programs for monitoring site deterioration and vandalism for each discrete area on the Arizona Strip.

2. Current survey techniques used in forested areas should be re-evaluated as regards their ability to detect sites of low visibility.

3. Site recording should include collection of a sample of diagnostic artifacts. If collections are not made, federal archaeologists should be given training, and time, to conduct adequate ceramic and lithic analyses to record sites properly in the field.

4. Existing computerized databases should be systematically examined for errors, and these errors should be corrected.

5. Computer software should be developed to link all federal cultural resource databases together.

6. Forest and Resource Area Archaeologists should be trained in the use of computer models as proposed in this document.

7. Long-term research projects by outside institutions should be supported and encouraged.

8. Ethnographic place name surveys should be conducted as part of the CRM process.

9. The BLM and the Forest Service should devote more efforts to experimental studies with sites in the management use category.

10. Cultural resource "management areas" should be considered as a means of enhancing historic and prehistoric properties and making them more available to the public.

A CLOSING COMMENT

We are clearly at a crossroads in the history of Arizona Strip archaeology. The last decade witnessed unparalleled growth in our knowledge of where sites are located on the Arizona Strip. But success has not come without a price. Although sites have been found, recording them in a fashion that provides data to all investigators has proved elusive. Paths for managing and disseminating new information have not been developed. Data synthesis has become so difficult that we are truly in danger of losing the forest for the trees.

The success of the next decade of CRM will not be measured so much by how many sites we find as by how well we do in explaining the human paths and processes that are reflected in those sites. This task is fraught with pitfalls; it also contains exciting challenges. It is to these challenges that all of us working on the Arizona Strip must dedicate ourselves.

BIBLIOGRAPHY

Aasen, Diane K.

1984 Pollen, Macrofossil and Charcoal Analyses of Basketmaker Coprolites from Turkey Pen Ruin, Cedar Mesa, Utah. Unpublished M.A. thesis, Department of Anthropology, Washington State University, Pullman.

Abel, Leland J.

1955 Pottery Types of the Southwest: Wares 5A, 10A, 10B, 12A, San Juan Red Ware, Mesa Verde Gray Ware, Mesa Verde White Ware, and San Juan White Ware. Museum of Northern Arizona Ceramic Series No. 3B, Flagstaff.

1965 Pottery Types of the Southwest. Museum of Northern Arizona, Ceramic Series No. 38. Flagstaff.

Abott, Chuck, and Esther Henderson

1943 Arizona Lumber Goes to War. Arizona Highways 19:1-2.

Abbott, David R.

1979 An Introduction to the Cultural Resources of the Kaibab Plateau. In Western Anasazi Reports 2:126-140.

Acker, Evan F.

1983 Painted Pots: An Attribute Analysis of Muddy River Ceramics. Unpublished M.A. thesis, Department of Anthropology, University of Nevada, Las Vegas.

Adams, Eleanor B.

1976 Fray Francisco Atanasio Dominguez and Fray Silvestre Velez de Escalante. Utah Historical Quarterly 44:40-58.

Adams, William Y., Alexander J. Lindsey, Jr., and Christy Turner

1961 Survey and Excavations in Lower Glen Canyon, 1952-1958. Museum of Northern Arizona Bulletin 36. (Glen Canyon Series, No. 3). Flagstaff.

Adovasio, James M.

1971 Some Comments on the Relationship of Great Basin Textiles of the Great Basin to Textiles from the Southwest. University of Oregon Anthropological Papers No. 1. Eugene.

1975 Fremont Basketry. Tebiwa 17(2):67-76.

1980 Fremont: An Artifactual Perspective. Utah State Historical Society Antiquities Section Selected Papers 7(16):35-40.

1986 Artifacts and Ethnicity: Basketry as an Indicator of Territoriality and Population Movements in the Prehistoric Great Basin. In Essays in Honor of Jesse D. Jennings, edited by Carol J. Condie and Don D. Fowler, pp.43-88. University of Utah Anthropological Papers No. 110. Salt Lake City.

Adovasio, James M., R. Carlisle, and R. Andrews
1978 An Evolution of Anasazi Basketry: A View from Antelope House. Journal of New World Archaeology 2(5):1-5.

Adovasio, James M. and J.D. Gunn
1986 The Antelope House Basketry Industry. In Archaeological Investigations at Antelope House, by Don P. Morris, pp. 306-397. USDI National Park Service, Washington, D.C.

Agenbroad, Larry D.
1975 The Alluvial Geology of Upper Grand Gulch, Utah: its Relationship to Anasazi Inhabitation of the Cedar Mesa Area. Four Corners Geological Society Guidebook, 8th Field Conference, Canyonlands, pp. 63-66.

Agenbroad, Larry D., Kirk Anderson, Julio Betancourt, Scott Clay Poole, Diana Elder, Richard H. Hevly, Eric Karlstrom, James I. Mead, and Larry Middleton
1986 Phase I Report: Quaternary Studies: Glen Canyon National Recreation Area and Canyonlands National Park. Report on file, National Park Service, Rocky Mountain Regional Office, Denver.

Agenbroad, Larry D., Kirk Anderson, Scott Clay Poole, Gloria J. Edwards, Diana Elder, Richard H. Hevly, and James I. Mead
1987 Phase II Report: Quaternary Studies in Glen Canyon National Recreation Area and Canyonlands National Park. Report on file, National Park Service, Rocky Mountain Regional Office, Denver.

Agenbroad, Larry D., Jim I. Mead, Emilee Mead, and Diana Elder
1987 Archaeology of Bechan Cave. In Phase II Report: Quaternary Studies in Glen Canyon National Recreation Area and Canyonlands National Park, by Larry D. Agenbroad et al. Report on file, National Park Service, Rocky Mountain Regional Office, Denver.

Aikens, C. Melvin
1965 Excavations in Southwest Utah. University of Utah .

1962 The Archaeology of the Kaiparowits Plateau, Southeastern Utah. Unpublished M.A. Thesis, Department of Anthropology, University of Chicago, Chicago.

1966 Virgin-Kayenta Cultural Relationships. University of Utah Anthropological Papers No. 79. Salt Lake City.

1970 Hogup Cave. University of Utah Anthropological Papers 93. Salt Lake City.

Aikens, Melvin C. and Younger T. Witherspoon
1986 Great Basin Numic Prehistory: Linguistics, Archaeology and Environment. In Essays in Honor of Jesse D. Jennings , edited by Carol J. Condie and Don D. Fowler, pp. 7-20. University of Utah Anthropological Papers No. 110. Salt Lake City.

Alley, John R., Jr.
1982 Prelude to Dispossession:The Fur Trade's Signigicance for the Northern Utes and Southern Paiutes. Utah Historical Quarterly 50:104-123.

Alter, J. Cecil
1941 Father Escalante's Map. Utah Historical Quarterly 9:64-72.

Altschul, Jeffrey H.
1983 Statistical Test of Site Location. In An Intensive Survey of a 2,200 Acre Tract within a proposed Maneuver Area at the Fort Benning Military Reservation, Chattachoochee County, Georgia, by Prentice M. Thomas, Jr., L. Janice Campbell, Mark T. Swanson, Jeffrey H. Altschul, and Carol S. Weed, pp. 107-128. New World Research, Report of Investigations 77. Pollock, Louisiana.

1988 Models and the Modeling Process. In Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling, edited by W. James Judge and Lynne Sebastian. Bureau of Land Management, Denver.

Altschul, Jeffrey H., and Christopher Nagle
1988 Collecting New Data for the Purpose of Model Building. In Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling, edited by W. James Judge and Lynne Sebastian. Bureau of Land Management, Denver.

Ambler, J. Richard
1984 A Synopsis of the Archaeology and Stratigraphy of Dust Devil Cave. Paper presented at the 19th Biennial Great Basin Anthropological Conference, Boise, Idaho.

1985 Northern Kayenta Ceramic Chronology. In Archaeological Investigations near Rainbow City, Navajo Mountain, Utah, edited by Phil Geib, J. Richard Ambler and Martha M. Callahan, pp. 28-68. Northern Arizona Archaeological Report No. 576, Northern Arizona University Archaeology Laboratory, Flagstaff.

1987 Navaho National Monument Archaeological Assessment, Southwest Cultural Resources Center Professional Papers No. 9, Santa Fe.

Ambler, J. Richard,Helen C. Fairley, and Phil R. Geib
1983 Kayenta Anasazi Utilization of Canyon and Plateaus in the Navajo Mountain District. Paper presented at the 2nd Anasazi Symposium, Farmington, New Mexico.

Ambler, J. Richard, Alexander J. Lindsay, Jr., and Mary Anne Stein
1964 Survey and Excavations on Cummings Mesa, Arizona and Utah, 1960-1961. Museum of Northern Arizona Bulletin No. 39, Flagstaff.

Ambler, J. Richard, and Mark Q. Sutton
1986 The Anasazi Abandonment of the San Juan Drainage and the Numic Expansion. Paper presented at the 1986 Pecos Conference, Payson, Arizona.

American Association of Petroleum Geologists
1967 Geologic Highway Map, Southern Rocky Mountain Region, Utah-Colorado-Arizona-New Mexico. American Association of Petroleum Geologists, Tulsa.

Amsden, Charles
1935 The Pinto Basin Artifacts. Southwest Museum Papers No. 9:33-51, Los Angeles.

1937 The Lake Mohave Artifacts. Southwest Museum Papers No. 11:51-98, Los Angeles.

Amsden, Monroe

n.d. Untitled manuscript on an archaeological reconnaissance of House Rock Valley, Fredonia and Kanab Creek area in June, 1930. Ms. on file, Gila Pueblo Collection, Arizona State Museum Archives, Tucson.

Anderson, Keith M.

1960 Utah Virgin Branch Plain Utility Pottery. Unpublished MA thesis, Department of Anthropology, University of Utah, Salt Lake City.

1963 Ceramic Clues to Pueblo-Puebloid Relationships. American Antiquity 28:303-307.

Anderson, Nels

1942 Desert Saints, the Mormon Frontier in Utah. University of Chicago Press, Chicago.

Anonymous

1926 Zion National Park, Bryce Canyon, North Rim Grand Canyon, North Rim Grand Canyon. Union Pacific System, Omaha.

Anonymous

1953a Kaibab Operations Established; High Priced Timber Reappraised. The Timberman 56:

Anonymous

1953b Southwest Gets an Outstanding New Logging and Sawmill Operation. The Lumberman 80:54-56.

Antevs, Ernst

1962 Late Quaternary Climates in Arizona. American Antiquity 28:193-198.

Arizona Department of Minerals Resources

1941 Production Possibilities of the Marginal Copper Mines in Arizona. Manuscript on file, Northern Arizona University Special Collections Library, Flagstaff.

Arnold, Dean E.

1981 A Model for the Identification of Non-local Ceramic Distributions: A View from the Present. In Production and Distribution: A Ceramic Viewpoint edited by H. Howard and E. Morris, pp. 31-44. BAR International Series 120, Oxford, England.

1985 Ceramic Theory and Cultural Process. Cambridge University Press, New York.

Arrington, Leonard J.

1954 Orderville, Utah: A Pioneer Mormon Experiment in Economic Organization. Utah State Agricultural College Monograph Series Vol. 2, No. 2. Logan.

1958 Great Basin Kingdom: An Economic History of the Latter Day Saints, 1830-1900. Harvard University Press, Cambridge.

1961 Utah and the Depression of the 1890's. Utah Historical Quarterly 24:3-20.

1963 The Changing Economic Structure of the Mountain West, 1850-1950. Utah State University, Logan.

1966 Inland to Zion: Mormon Trade on the Colorado River, 1864-1867. Arizona and the West 8:239-250.

Arrington, Leonard J., and Davis Bitton
1979 The Mormon Experience: A History of the Latter Day Saints. Alfred A. Knopf, Inc., New York.

Aschmann, Homer
1959 The Central Desert of Baja California:Demography and Ecology. Ibero-Americana 42. University of California, Berkeley.

Auerbach, Herbert S.
1941a Old Trails, Old Forts, Old Trappers and Traders. Utah Historical Quarterly 9:13-16.

1941b Father Escalante's Route (as depicted by the map of Bernardo de Miera y Pacheco). Utah Historical Quarterly 9:109-128.

1943a Father Escalante's Journal, 1776-77. Utah Historical Quarterly 11:1-142.

1943b Father Escalante's Journal with Related Documents and Maps. Utah Historical Quarterly 12:1-132.

Bailey, G.
1983 Hunter-gatherer Economy in Prehistory. Cambridge University Press, Cambridge, England.

Bailey, Lynn R.
1964 The Long Walk: A History of the Navajo Wars, 1846-1868. Western Lore Press, Los Angeles.

Baldwin, Gordon C.
1942a Archaeological Field Work in the Boulder Dam Area. Clearinghouse for Southwestern Museums, News Letter 51:186-187. Denver.

1942b Archaeology in Southern Nevada. The Kiva 7:13-16.

1944 An Occurrence of Jeddito Black on Yellow Pottery in Northwestern Arizona North of the Grand Canyon. Plateau 17:14-16.

1945 Notes on Ceramic Types in Southern Nevada. American Antiquity 10:389-390.

1946 Notes on Rampart Cave. Masterkey 20:94-96.

1948 Notes on Colorado River Basin Archaeology. American Antiquity 14:128-129.

1950a Archaeological Survey of the Lake Mead Area. In For the Dean: Essays in Anthropology in Honor of Byron Cummings, edited by Erik K. Reed and Dale S. King, pp. 41-49. Hohokam Museums Association and Southwestern Monuments Association, Tucson and Santa Fe.

1950b The Pottery of the Southern Paiute. American Antiquity 16:50-56.

1978 Archaeological Survey of Whitmore Wash and Shivwits Plateau, Northwestern Arizona. Western Anasazi Reports 1:13-22. Cedar City, Utah.

Balsom, Janet R.
1984 Application of Heavy Mineral Analysis to Grand Canyon Ceramics, Unpublished M.A. thesis, Department of Anthropology, Arizona State University, Tempe.

Bancroft, Hubert Howe
1889a The Works of Hubert Howe Bancroft: The History of Arizona and New Mexico, 1530-1888. The History Company, San Francisco.

1889b The Works of Hubert Howe Bancroft: The History of Utah, 1540-1886. The History Company, San Francisco.

Bannister, Bryant, Jeffrey S. Dean, and William J. Robinson
1969 Tree Ring Dates from Utah S-W: Southern Utah Area. Laboratory of Tree Ring Research, University of Arizona, Tucson.

Barnes, Will C.
1927 The Bison of House Rock Valley. Nature 10:216-221.

1934 The Honeymoon Trail to Utah. Arizona Highways (December):6-7, 17.

1935 Arizona Place Names. University of Arizona Press, Tuscon.

Barth, Fredrick, editor
1969 Ethnic Groups and Boundaries. Little, Brown & Co., Boston.

Bartlett, Richard A.
1962 Great Surveys of the American West. University of Oklahoma Press, Norman.

Batman, Richard
1984 American Ecclesiastes: The Stories of James Pattie. Harcourt, Brace and Janovich, New York.

Beadle, J.H.
1873 The Undeveloped West or Five Years in the Territories. National Publishing Company, Philadelphia.

Beal, John D.
1973 Tapeats Creek Survey. Ms. on file, National Park Service, Western Archaeological and Conservation Center, Tucson.

Beals, Ralph L., George W. Brainerd, and Watson Smith
1945 Archaeological Studies in Northeast Arizona. University of California Publications in American Archaeology and Ethnology 44(1). University of California Press, Berkeley.

Bean, Lowell J., and Sylvia B. Vane
1981 Native American Places in the San Bernardino National Forest, San Bernardino and Riverside Counties, California. Report submitted to the USDA-Forest Service by Cultural System Research, Inc.

Bedwell, Stephen F.
1970 Prehistory and Environment of the Pluvial Fort Rock Lake Area of South Central Oregon. PhD. dissertation, Department of Anthropology, University of Oregon, Eugene.

Bedwell, Stephen F.
1973 Fort Rock Basin Prehistory and Environment. University of Oregon Books, Eugene.

Belknap, William, Jr.
1941 The Saga of Queho, the Paiute Renegade who found Death in a cave in Colorado Canyon below Boulder Dam. Arizona Highways 17(9):28-29,33.

Belshaw, Michael
1978 High, Dry, and Lonesome: The Arizona Strip and Its People. The Journal of Arizona History 19:359-378.

1979a The Dunn-Howland Killings: A Reconstruction. Journal of Arizona History 20:409-422.

1979b Mines and Mining Districts in the Lake Mead National Recreational Area:Supplement to Lake Mead National Recreation Area Historical Resources Study. Manuscript on File, Museum of Nortern Arizona, Flagstaff.

n.d. Human Ecology of the Arizona Strip: A Cursory Discussion. Ms. on file, Museum of Northern Arizona, Flagstaff.

Belshaw, Michael, and Ed Peplow, Jr.
1978 Historic Resources Study, Lake Mead National Recreation Area, Arizona. Ms. on file, National Park Service, Western Archaeologcial and Conservation Center, Tucson.

Bender, A. B.
1952 The March of Empire: Frontier Defense in the Southwest, 1848-1860. University of Kansas Press, Lawrence.

Benedict, James B.
1975 Prehistoric Man and Climate: The View from Timberline. In Quaternary Studies, edited by R. P. Suggate and M. M. Cresswell, pp. 67-74. The Royal Society of New Zealand, Wellington.

1979 Getting Away from It All: A Study of Man,Mountains, and the Two-Drought Altithermal. Southwestern Lore 45:1-12.

1981 The Fourth of July Valley: GlacialGeology and Archaeology of the Timberline Ecotone. Center for Mountain Archaeology Research Report No. 2. Ward, Colorado.

Benedict, James B. and Byron L. Olson
1973 Origins of the McKean Complex: Evidence from Timberline. Plains Anthropologist 18:323-327.

1978 The Mount Albion Complex: A Study of Prehistoric Man and the Altithermal. Center for Mountain Archaeology Research Paper 1. Ward, Colorado.

Bernheimer, Charles L.
n.d. Field Notes, Bernheimer Expeditions of 1922, 1923, 1924, 1926, 1927, 1929, 1930 for the American Museum of Natural History. Ms. on file, Utah State Historical Society, Salt Lake City.

1924 Rainbow Bridge: Circling Navajo Mountain and Explorations in the "Bad Lands" of Southern Utah and Northern Arizona. Doubleday, New York.

Berry, A. Carolyn
1974 The Use of Non-metrical Variations of the Cranium in the Study of Scandinavian Population Movements. American Journal of Physical Anthropology 40:345-358.

Berry, Claudia F., and Michael S. Berry
1986 Chronological and Conceptual Models of the Southwestern Archaic. In Essays in Honor of Jesse D. Jennings , edited by Carol J. Condie and Don D. Fowler, pp. 252-327. University of Utah Anthropological Papers No. 110. Salt Lake City.

Berry, Michael S.
1982 Time, Space and Transition in Anasazi Prehistory. University of Utah Press, Salt Lake City.

Berry, Michael S. and Claudia F. Berry
1976 An Archaeological Reconnaissance of the White River Area, Northeastern Utah. Antiquities Section Selected Papers 2(4). Utah State Historical Society, Salt Lake City.

Betancourt, Julio L.
1984 Late Quaternary Plant Zonation and Climate in Southeastern Utah. The Great Basin Naturalist 44(1):1-35.

1987 Paleoecology of Pinyon-Juniper Woodlands: Summary. In Proceedings - Pinyon-Juniper Conference, compiled by Richard Everett, pp. 129-139. USDA Forest Service, Intermountain Research Station, General Technical Report INT-215.

Betancourt, Julio L., and Thomas R. Van Devender
1984 Holocene Vegetation in Chaco Canyon, New Mexico. Science 214:656-658.

Bettinger, Robert L., and Martin A. Baumhoff
1982 The Numic Spread: Great Basin Cultures in Competition. American Antiquity 47:485-503.

Bettinger, Robert L., and R.E. Taylor
1974 Suggested Revisions in Archaeological Sequences of the Great Basin in Interior Southern California. Nevada Archaeological Survey Research Papers 5:1-26.

Bieber, Ralph P.
1925 The Southwestern Trails to California in 1849. Mississippi Valley Historical Review 12.

Bieber, Ralph P. and Averam Bender, editors
1936 Exploring Southwestern Trails. Southwestern History Series Vol. 7. Arthur H. Clark, Co., Glendale, California.

Bieber, Ralph P. and LeRoy Hafen, editors
1943 The Southwestern Historical Series: Historical Documents Hitherto Unpublished or Inaccessible Depicting Social and Economic Conditions in the Southwest during the Nineteenth Century. Arthur H. Clark, Co., Glendale, California.

Bielicki, Tadeusz
1962 Some Possibilities for Estimating Inter-Population Relationship on the Basis of Continuous Traits. Current Anthropology 3:3-46.

Billet, Lorna
1987 Virgin Valley Archaeological Project. Of Human Interest:The Newsletter of BYU Anthropology and Archaeology 3(1):1-2.

Billingsley, George H.
1976a Prospector's Proving Ground: Mining in Grand Canyon. Journal of Arizona History 17:69-88.

1976b Springs of Western Grand Canyon. Ms. on file, Museum of Northern Arizona, Flagstaff.

Billington, Ray A.
1956 The Far Western Frontier, 1830-1860. (1st Edition), Harpes, New York.

Binford, Lewis R.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site formation. American Antiquity 45:4-20.

1982 The Archaeology of Place. Journal of Anthropological Archaeology 1:5-13.

Blasing, Terrence J.
1975a A Comparison of Map-Pattern Correlation and Principal Component Eigenvector Methods for Analyzing Past Climatic Anomaly Patterns. Proceedings of the Fourth Conference on Probability and Statistics in Atmospheric Sciences:96-101. American Meteorological Society, Tallahasee, Florida.

1975b Methods for Analyzing Climatic Variations in the North Pacific Sector and Western North America for the Past Few Centuries. Ph.D dissertation, The University of Wisconsin, Madison. University Microfilms, Ann Arbor.

Blasing, Terrence J., and Harold C. Fritts
1976 Reconstructing Past Climatic Anomalies in the North Pacific and Western North America from Tree-Ring Data. Quaternary Research 6:563-579.

Blinman, Eric
1987 Analysis of Cermics from the Project Sites. In Green Springs: An Anasazi and Southern Paiute Encampment in the St. George Basin of Utah, by Deborah A. Westfall, William E. Davis, and Eric Blinman. pp. 6-48. USDI Bureau of Land Management, Utah, Cultural Resource Series 21. Salt Lake City.

Bohrer, Vorsila L.
1968 Paleoecology of an Archaeological Site near Snowflake, Arizona. Ph.D. dissertation, University of Arizona. University Microfilms, Ann Arbor.

1972 Paleoecology of the Hay Hollow Site, Arizona. Fieldiana Anthropology 63:1-30.

Boison, P. J.
1983 Late Pleistocene and Holocene Alluvial Stratigraphy of Three Tributaries of the Escalante River Basin, Utah. Unpublished M.S. thesis, University of California, Santa Cruz.

Boison, P. J., and P. C. Patton
1985 Sediment Storage and Terrace Formation in Coyote Gulch Basin, South-Central Utah. Geology 13:31- 34.

Bolton, Herbert E.
1928 Escalante in Dixie and the Arizona Strip. New Mexico Historical Review 3:41-72.

1950 Pageant in the Wilderness: The Story of the Escalante Expedition into the Interior Basin, 1776, Including the Diary and Itinerary of Father Escalante, Translated and Annotated. Utah Historical Society, Salt Lake City.

1952 Spanish Exploration in the Southwest, 1542-1706. Barnes and Noble, New York.

Bonar, Linda L.
1983 Historical Houses in Beaver: An Introduction to Materials, Styles, and Craftsmanship. Utah Historical Quarterly 51:212-228.

Bond, Mark
1982 Archaeological Investigations on the Garkane Power Association Hack Canyon Powerline Right-of-Way, Northern Mohave County, Arizona. Unpublished report submitted by Abajo Archaeology to the Bureau of Land Management, Arizona Strip District, St. George, Utah.

1987 Analysis of Ceramics from the Pinenut Site. In The Pinenut Site: Virgin Anasazi Archaeology on the Kanab Plateau of Northwestern Arizona, by Deborah A. Westfall. USDI Bureau of Land Management, Arizona, Cultural Resource Series 4. Phoenix.

Bradford, James E.
1974 Final Report for An Archaeological Survey of the Paria Canyon from the Arizona Utah State Border to the Glen Canyon National Recreation Area Boundary. Unpublished report submitted by the Museum of Northern Arizona to the Bureau of Land Management, Arizona Strip District, St. George, Utah.

Bradley, Zorro A.
1960 The Whitmore-McIntyre Dugout, Pipe Spring National Monument, Part I:History; Part II:Excavation. Plateau 33:40-45, 69-82.

Brandes, Ray
1960 Frontier Military Posts in Arizona. Dale S. King, Globe, Arizona.

Bremer, Michael J., and Phil R. Geib
n.d. Archaeology of the Orange Cliffs Tar Sands Triangle. Northern Arizona University Archaeological Report No. 997.

Breternitz, David A.
1966 An Appraisal of Tree Ring Dated Pottery in the Southwest. Anthropological Papers of the University of Arizona No. 10, Tucson.

Breternitz, David A., Arthur H. Rohn, and Elizabeth A. Morris
1974 Prehistoric Ceramics of the Mesa Verde Region. Museum of Northern Arizona Ceramic Series No. 5. Flagstaff.

Briggs, Walter
1976 Without Noise of Arms: The 1776 Dominguez-Escalante Search For a Route From Sante Fe to Monterey. Northland Press, Flagstaff.

Bronitsky, Gordon, and James D. Merritt

1986 The Archaeology of Southeast Arizona: A Class I Cultural Resource Inventory. Bureau of Land Management, Cultural Resource Series 2. Phoenix.

Brook, Richard A.

1979 The Cultural Resources of the Grand Canyon Cross Canyon Corridor Survey. Western Anasazi Reports 2:75-122.

Brooks, George

1977 The Southwest Expedition of Jedediah S. Smith. Arthur H. Clark, Co., Glendale, California.

Brooks, Juanita

1943 Jacob Hamblin: Apostle to the Indians. Arizona Highways (April):31-35.

1944a Indian Relations on the Mormon Frontier. Utah Historical Quarterly 12:1-48. Salt Lake City.

1944b Journal of Thales H. Haskell. Utah Historical Quarterly 12:68-98. Salt Lake City.

1949 The Arizona Strip. Pacific Spectator 3:290-301.

1957 Lee's Ferry at Lonely Dell. Utah Historical Quarterly 25:283-296.

Brooks, Richard H. and Daniel O. Larson

1975 Prehistoric and Historic Research along the Navaho-McCullough Transmission Line Right of Way. Manuscript on file, Nevada Archaeological Survey, University of Nevada, Las Vegas.

Brown, David E.

1982a Great Basin Conifer Woodland. In Biotic Communities of the American Southwest: United States and Mexico. edited by David E. Brown, pp. 52-57. Desert Plants, Vol. 4, No. 1-4, University of Arizona Press, Tucson.

1982b Montane Meadow Grassland. In Biotic Communities of the American Southwest: United States and Mexico. edited by David E. Brown, pp.113-114. Desert Plants, Vol. 4, No. 1-4, University of Arizona Press, Tucson.

1982c Plains and Great Basin Grasslands. In Biotic Communities of the American Southwest: United States and Mexico. edited by David E. Brown, pp. 115-120. Desert Plants, Vol. 4, No. 1-4, University of Arizona Press, Tucson.

Brown, David E., editor

1982 Biotic Communities of the American Southwest - United States and Mexico. Desert Plants, Vol. 4, No. 1-4. University of Arizona Press, Tucson.

Brown, David E., Charles H. Lowe, and Charles P. Pase

1979 A Digitized Classification System for the Biotic Communities of North America with Community and Association Examples for the Southwest. Journal of the Arizona-Nevada Academy of Science 14(Supplement 1):1-16.

Brown, David E., Charles H. Lowe, and Charles P. Pase
1982a The Kanab North Project: Archaeological Survey and Mitigation West of Kanab Creek Canyon, Mohave County, Arizona. Unpublished report submitted by Abajo Archaeology to the Bureau of Land Management, Arizona Strip District, St. George, Utah.

1982b Archaeological Investigations at Yankee Target, A Prehistoric Chert Quarry on the Arizona Strip, Northwest Mohave County, Arizona. Submitted by Abajo Archaeology to the Bureau of Land Management, Arizona Strip District, St. George, Utah.

Brown, James A.
1904 Report of the Special Agent Sent For The Kaibab Indians. In: Annual Report of the Commissioner of Indian Affairs, Part 1, pp. 329-330. Government Printing Office, Washington, D.C.

Brown, John
1941 Autobiography of Pioneer John Brown, 1820-1896. John Z. Brown, Salt Lake City.

Brown, Margaret Kimball, editor
1981 Predictive Models in Illinois Archaeology. Illinois Department of Conservation, Springfield.

Brugge, David M.
1968 Navajos in the Catholic Church Records of New Mexico, 1694-1875. Navajo Tribe Parks and Recreation Department Research Report 1. Window Rock, Arizona.

Brunson, Janice and William Coats, editors
1980 Kaibab Paiutes: Nomads, Neighbors, New Developments. Indian Arizona News: The Magazine about Arizona Indian Reservations 2(11):3,6,14-15.

Bryan, Kirk
1922 Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest. Science 62:338-344.

1940 Erosion in the Valleys of the Southwest. New Mexico Quarterly 10:227-232.

1954 The Geology of Chaco Canyon, New Mexico, in Relation to the Life and Remains of Prehistoric Peoples of Pueblo Bonito, Smithsonian Miscellaneous Collections 122:1-65.

Bryan, Kirk, and Joseph H. Toulouse, Jr.
1943 The San Jose Non-ceramic Culture and Its Relation to a Puebloan Culture in New Mexico. American Antiquity 8:269-280.

Bryson, R. A., and W. P. Lowry
1955 Synoptic Climatology of the Arizona Summer Precipitation Singularity. Bulletin of the American Meteorological Society 36:329-339.

Buckles, William G.
1968 Archaeology in Colorado: Historic Tribes. Southwestern Lore 34:53-67.

Bufkin, Donald
1964 The Lost County of Pah-Ute. Arizoniana:The Journal of Arizona History 5(2):1-11.

Buikstra, Jane and Della C. Cook
1980 Paleopathology: An American Account. Annual Review of Anthropology 9:433-470.

Bunte, Pamela
1979 Problems in Southern Paiute Syntax and Semantics. Unpublished PhD. dissertation, Department of Anthropology, Indiana University, Bloomington.

Bureau of Land Management
1980 Arizona Strip Wilderness Draft Environmental Impact Statement and Suitability Report. U.S. Department of the Interior, Bureau of Land Management, Arizona Strip District, St. George, Utah.

Bye, Robert A., Jr.
1972 Ethnobotany of the Southern Paiute Indians in the 1870's with a Note on the Early Ethnobotanical Contributions of Dr. Edward Palmer. In Great Basin Cultural Ecology: A Symposium, edited by Don D. Fowler. Desert Research Institute Publications in the Social Sciences No. 8. University of Nevada, Reno.

Calef, Wesley
1960 Private Grazing and Public Lands:Studies of the Local Management of the Taylor Grazing Act. University of Chicago Press, Chicago.

Callahan, Martha M. and Helen C. Fairley
1983 Rainbow Gray: A Distinctive Utility Ware in the Northern Kayenta Region. Pottery Southwest 10(2):1-6.

Campbell, Elizabeth W. C., and William H. Campbell
1935 The Pinto Basin Site. Southwest Museum Papers No. 9, Los Angeles.

Campbell, Eugene E.
1973 Brigham Young's Outer Cordon: A Reappraisal. Utah Historical Quarterly 41:220-253.

Cannon, Kenneth L. II
1978 Beyond Manifesto: Polygamous Cohabitation among LDS General Authorities after 1890. Utah Historical Quarterly 46:24-36.

Carlson, Roy L.
1983 The Far West. In Early Man in the New World, edited by Richard Shutler, Jr., pp. 73-96. Sage Publications, Beverly Hills.

Carmichael, Tony
1980 The Wild Goose Site: A Virgin Branch Site in Northwestern Arizona. Ms. on file, Arizona State Museum, Tucson.

Chisholm, Brian
1986 Unpublished PhD. dissertation, Department of Anthropology, Simon Fraser University, Burnaby, B.C.

Chisholm, Brian, and R.G. Matson
n.d. Basketmaker II Utilization of Maize at Cedar Mesa, Utah. Ms. in possession of the authors.

Clawson, Marion
1971 The Bureau of Land Management. Praeger Publishers, New York.

Cleeland, Teri
1987a Brow Monument National Register of Historic Places Nomination. Manuscript on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

1987b Jacob Lake Ranger Station National Register of Historic Places Nomination. Manuscript on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Cleland, Robert G.
1952 This Reckless Breed of Men: The Trappers and Fur Traders of the Southwest. Alfred A. Knopf, New York.

Cleland, Robert G., and Juanita Brooks, editors
1983 A Mormon Chronicle: The Diaries of John D. Lee, 1848-1876. Huntington Library, San Marino. California. 2 vols.

Coconino County
n.d. Millsites and Water Rights Book. On file, Coconino County Recorder's Office, Coconino County Courthouse, Flagstaff.

n.d. Mining Claims Records. On file, Coconino County Recorder's Office, Coconino County Courthouse, Flagstaff.

Cody, Bertha P.
1942 Simply Strung on a Single Strand. The Masterkey 16:175-176.

Coker, Elizabeth
1978 Historical Resources of the Kaibab National Forest. Ms. on file, Kaibab National Forest, Williams, Arizona.

Colton, Harold S.
1939 An Archaeological Survey of Northwestern Arizona Including the Descriptions of Fifteen New Pottery Types. Museum of Northern Arizona Bulletin No. 15. Flagstaff.

1942 Archaeology and the Reconstruction of History. American Antiquity 8:1-33.

1943 Reconstruction of Anasazi History. Proceedings of the American Philosophical Society 86:264-269.

1945 Another Unfired Sherd from Black Dog Cave: Logandale Gray. Plateau 17:69-70.

1952 Pottery Types of the Arizona Strip and Adjacent Areas in Utah and Nevada. Museum of Northern Arizona Ceramic Series No. 1. Flagstaff.

1956 Pottery Types of the Southwest: Wares 5A, 5B, 6B, 7A, 7B, 7C, San Juan Red Ware, Homolovi Orange Ware, Winslow Orange Ware, Awatovi Yellow Ware, Jeddito Yellow Ware, Sichomovi Red Ware. Museum of Northern Arizona Ceramic Series No. 3C. Flagstaff.

Colton, Harold S., and L. L. Hargrave
1937 Handbook of Northern Arizona Pottery Wares. Museum of Northern Arizona Bulletin No. 11. Flagstaff.

Cooke, Ronald U., and Richard W. Reeves
1976 Arroyos and Environmental Change in the American South-West. Clarendon Press, Oxford.

Corbett, Pearson
1952 Jacob Hamblin, The Peace Maker. Deseret Book Company, Salt Lake City.

Cordell, Linda S.
1979 Cultural Resource Overview, Middle Rio Grande Valley, New Mexico. Submitted to USDA Forest Service, Southwest Regional and U.S. Department of Interior, Bureau of Land Management, New Mexico State Office, Albuquerque.
1984 Prehistory of the Southwest. Academic Press, New York.

Cordell, Linda S., and Dee F. Green, editors
1983 Theory and Model Building: Refining Survey Strategies for Locating Prehistoric Heritage Resources. USDA Forest Service, Southwest Region, Cultural Resources Document 3. Albuquerque.

Cordell, Linda S., and Steadman Upham
1983 Agriculture in the Southwest. In Theory and Model Building: Refining Survey Strategies for Locating Prehistoric Heritage Resources, edited by Linda S. Cordell and Dee F. Green, pp. 39-58. USDA Forest Service, Southwest Region, Cultural Resources Document 3. Albuquerque.

Corruccini, Robert
1972 The Biological Relationship of Some Prehistoric and Historic Pueblo Populations. American Journal of Physical Anthropology 37:373-388.

1974 An Examination of the Meaning of Cranial Discrete Traits for Human Skeletal Populations. American Journal of Physical Anthropology 40:425-445.

Count, E. W.
1930 A Grand Canyon Cliff Ruin. Grand Canyon Nature Notes 4(5):31.

Cox, Nellie I.
1982 A Harsh Land and Proud: Saga of the Arizona Strip. Cox Printing, Las Vegas.

Cox, Nellie I., and Helen B. Russell
1973 Footprints on the Arizona Strip. Horizon Publishers, Bountiful, Utah.

Crampton, C. Gregory
1960 Historical sites in Glen Canyon, Mouth of the San Juan River to Lee's Ferry. University of Utah Anthropological Papers, Glen Canyon Series 12.

1965 Mormon Colonization in Southern Utah and Adjoining Parts of Arizona and Nevada, 1851-1900. Report prepared for National Park Service. Manuscript on file, Grand Canyon National Park, Study Collections Library, Grand Canyon.

1969 F.S. Dellenbaugh of the Colorado: Some Letters Pertaining to the Powell Voyages and the History of the Colorado River. Utah Historical Quarterly 27:214-243.

1975 Introduction. In Sharlot Hall on the Arizona Strip: A Diary of a Journey Through Northern Arizona in 1911, edited by C. Gregory Crampton, pp. 1-10. Northern Press, Flagstaff, Arizona.

Crampton, C. Gregory
1985 Land of the Living Rock: The Grand Canyon and the High Plateaus: Arizona, Utah and Nevada. Peregrine Smith Books, Layton, Utah. (Originally published by Knopf, New York, 1972.)

Crampton, C. Gregory, and David E. Miller, editors
1961 Journal of Two Campaigns by Utah Territorial Militia Against the Navaho Indians, 1869. Utah Historical Quarterly 29:148-176.

Creer, L.H.
1958 The Activities of Jacob Hamblin in the Region of the Colorado. University of Utah Anthropological Papers No. 33 (Glen Canyon Series No. 4). Salt Lake City.

Crittenden, Hiram Martin
1901 The American Fur Trade of the Far West. 3 Volumes. F. P. Harper, New York.

Crosby, Alfred W., Jr.
1972 The Columbian Exchange: Biological and Cultural Consequences of 1492. Contributions in American Studies Series, No. 2. Greenwood Press, Westport, Connecticut.

Cutler, Hugh C.
1966 Corn, Cucurbits, and Cotton from Glen Canyon. University of Utah Anthropological Papers 80. Salt Lake City.

Cutler, Hugh C., and Leonard W. Blake
1980 Plant Materials from Grand Canyon Sites. In Archaeology of the Grand Canyon: Unkar Delta, by Douglas Schwartz, Richard C. Chapman, and Jane Kepp, pp. 209-212. Grand Canyon Archaeological Series No. 3. School of American Research Press, Santa Fe.

Cutting, Hayward, T.G. Pearson, T.W. Tomlinson, and J.R. Burnham
1924 Kaibab Deer Investigating Committee Report, Oct. 1, 1924. Manuscript on file, United States Department of Agriculture, Forest Service, Wildlife Management Division, (Grand Canyon Game Preserve File Folder, R-3 Kaibab). Washington, D.C.

Dale, Harrison C.
1941 Ashley-Smith Explorations and Discovery of a Central Route to the Pacific, 1822-1829. Arthur H. Clark, Glendale, California.

Dalley, Gardiner F. and Douglas A. McFadden
1985 The Archaeology of the Red Cliffs Site. Bureau of Land Management, Utah, Cultural Resource Series No. 17. Salt Lake City.

Dalton, George
1977 Aboriginal Economics in Stateless Societes. In Exchange Systems in Prehistory, edited by T. Earle and J. Ericson, pp. 191-212. Academic Press, New York.

Darrah, William C.
1951 Powell of the Colorado. Princeton University Press, Princeton.

Darrah, William C., editor

1947 Biographical Sketches and Original Documents of the first Powell Expedition of 1869. Utah Historical Quarterly 15:1-148.

Darrah, William C., Herbert E. Gregory, and Charles Kelly

1948-1949 The Exploration of the Colorado River and the High Plateaus of Utah of the Second Powell Expedition of 1871-1872. Utah Historical Quarterly 16 17:1-540.

Davis, Alan C., R.E. Taylor, and Gerald A. Smith

1981 New Radiocarbon Determinations from Newberry Cave. Journal of California and Great Basin Anthropology 3(1):144-147.

Davis, Emma Lou

1964 Anasazi Mobility and Mesa Verde Migrations. Ph.D. Dissertation, Department of Anthropology, University of California, Los Angeles. University Microfilms, Ann Arbor.

1967 Man and Water at Pleistocene Lake Mohave. American Antiquity 32:345-353.

1969 The Western Lithic Co-Tradition. In The Western Lithic Co-Tradition, by Emma Lou Davis, C.W. Brott, and D.L. Weide, pp. 11-78. San Diego Museum Papers No. 6. San Diego.

1978 The Ancient Californians: Ranchocabrean Hunters of the Mohave Lakes Country. Natural History Museum of Los Angeles County Science Series No. 29, Los Angeles.

Davis, Emma Lou, and Richard H. Shutler

1969 Recent Discoveries of Fluted Points in California and Nevada. Nevada State Museum Anthropological Papers No. 14, Miscellaneous Paper No. 7. Carson City.

Davis, M. B.

1966 Determination of Absolute Pollen Frequency. Ecology 47:310-311.

Davis, Owen K.

1987 Palynological Evidence for Historic Juniper Invasion in Central Arizona: A Late Quaternary Perspective. In Proceedings: Pinyon-Juniper Conference, compiled by Richard Everett, pp. 120-124. USDA Forest Service, Intermountain Research Station, General Technical Report INT-215.

Davis, William E.

1982a An Archaeological Environmental Impact Survey of a Road Right-of-way, Fredonia, Arizona (Pigeon Mine Access Road). Submitted by Abajo Archaeology to Bureau of Land Management, Arizona Strip District, St. George, Utah.

1982b Archaeological Investigations on the Garkane Power Association Pigeon Mine Powerline Right-of-Way, Coconino County, Arizona. Submitted by Abajo Archaeology to the Bureau of Land Management, Arizona Strip District, St. George, Utah.

1985 The Montgomery Folsom Site. Current Research in the Pleistocene 2:11-12.

Davis, William E., and Gary M. Brown

1986 The Lime Ridge Clovis Site. Current Research in the Pleistocene 3:

Davis, William E., and Deborah A. Westfall
1982 Cultural Resource Investigations Along the Proposed Garkane Association Pigeon Mine Powerline, Northern Kaibab National Forest, Coconino County, Arizona. Submitted by Abajo Archaeology to the U.S. Department of Agriculture, Kaibab National Forest, Williams, Arizona.

Dean, Jeffrey S.
1969 Chronological Analysis of Tsegi Phase Sites in Northeastern Arizona. Papers of the Laboratory of Tree-Ring Research 3. University of Arizona, Tucson.

1978 Tree Ring Dating in Archaeology. University of Utah Anthropological Papers 99:129-163, Salt Lake City.

1982 Grand Canyon Prehistory. The Quarterly Review of Archaeology:10-11.

1984 Environmental Aspects of Modeling Human Activity Locating Behavior. In Theory and Model Building: Refining Survey Strategies for Locating Prehistoric Heritage Resources-Trial Formulations for Southwestern Forests, edited by Linda S. Cordell and Dee F. Green,USDA Forest Service, Southwestern Region, pp. 8-20.

Dean, Jeffrey S., Robert C. Euler, George J. Gumerman, Fred Plog, Richard H. Hevly, and Thor N. V. Karlstrom
1985 Human Behavior, Demography, and Paleoenvironment on the Colorado Plateaus. American Antiquity 50:537-554.

Dean, Jeffrey S., and William J. Robinson
1977 Dendroclimatic Variability in the American Southwest, A.D. 680 to 1970. Laboratory of Tree Ring Research, University of Arizona, Tucson.

1978 Expanded Tree Ring Chronologies for the Southwestern United States. Chronology Series 3, Laboratory of Tree Ring Research, University of Arizona, Tucson.

Dellenbaugh, Frederick S.
1962 Romance of the Colorado. The Rio Grande Press, Chicago. (Originally published in 1904).

1984 A Canyon Voyage: The Narrative of the Second Powell Expedition Down the Green-Colorado River from Wyoming, and the Explorations on Land, in the Years 1871 and 1872. University of Arizona Press, Tucson. (Originally published Putnam, New York, 1908.)

DeNiro, M. J., and S. Epstein
1978 Influence of Diet on the Distribution of Carbon Isotopes in Animals. Geochimica et Cosmochimica Acta 42:495-506.

1981 Influence of Diet on the Distribution of Nitrogen Isotopes in Animals. Geochimica et Cosmochimica Acta 45:341-351.

DeSart, D. J.
1970 A Study of Paiute and Shoshone Pottery. Ms. on file, Western Studies Center, Desert Research Institute, University of Nevada, Reno.

Deutchman, Haree L.
1979 Intra-regional Interaction on Black Mesa and Among the Kayenta Anasazi: The Chemical Evidence for Prehistoric Ceramic Exchange. Ph.D. Dissertation, Department of Anthropology, Southern Illinois University. University Microfilms, Ann Arbor.

Dickey, Archie M.
1971 Palynology of Hay Hollow Valley. Unpublished Master's thesis, Department of Biology, Northern Arizona University, Flagstaff.

Dobyns, Henry F.
1966 Estimating Aboriginal American Population:An Appraisal of Techniques with a New Hemispheric Estimate. Current Anthropology 7:395-416.

1976 Native American Historical Demography: A Critical Bibliography. Newberry Library Center for the History of the American Indian, Indiana University, Bloomington.

Dobyns, Henry F. and Robert C Euler
1980 The Dunn-Howard Killings:Additional Insights. Journal of Arizona History 21:87-94.

Dorrah, V. H. Jr.
1946 Certain Hydrological and Climatic Characteristics of the Southwest. University of New Mexico Publications in Engineering No. 1, Albuquerque.

Drew, Linda G., editor
1972 Tree Ring Chronologies of Western America: II: Arizona, New Mexico, Texas. Chronology Series 1, Laboratory of Tree Ring Research, University of Arizona, Tucson.

Duffield, M. S.
1904 Aboriginal Remains in Nevada and Utah. American Anthropologist 6:148-150.

Dunning, Charles H.
1948 A Report on Hack's Canyon Uranium Mine. Arizona Department of Mineral Resources, Tucson.

Dunning, Charles H. with Edward H. Peplow, Jr.
1959 Rocks to Riches: The Story of American Mining, Past, Present, and Future, As Reflected in the Colorful History of Mining in Arizona, The Nation's Greatest Bonanza. Southwest Publishing Company, Phoenix.

Dutton, Clarence E.
1882 Tertiary History of the Grand Canyon District, With Atlas. Monographs of the United States Geological Survey No. 2. (Reprinted by Peregrine-Smith, Inc., Salt Lake City, 1977.)

Easton, Robert, and Mackenzie Brown
1961 Lord of the Beasts: The Saga of Buffalo Jones. University of Arizona Press, Tucson.

Eddy, Frank W.
1961 Excavations at Los Pinos Phase Sites in the Navajo Reservoir District. Museum of New Mexico Anthropological Papers No. 4. Santa Fe.

Effland, Richard W., Jr., A. Trinkle Jones, and Robert C. Euler
1981 The Archaeology of Powell Plateau: Regional Interaction at Grand Canyon. Grand Canyon Natural History Association Monograph No. 3. Grand Canyon.

Ellis, Robert
1982 A Proposal to Conduct a Cultural Resource Survey in the Billy Goat Peak Area of Southern Nevada: A Continuation of the Archaeological Research and Regional Planning for the Southern Nevada Area. Prepared for the Nevada State Historic Preservation Office by the Archaeological Research Center, Museum of Natural History, University of Utah, Las Vegas.

Ellis, Robert, Richard H. Brooks, Eileen Green, and Teri Swearingen
1982 A Cultural Resources Survey and Limited Test Excavations in the Vicinities of Quail Point, Bunkerville Ridge, and Hackberry Spring, Virgin and Mormon Mountains, Southern Nevada. Archaeological Research Center Report 21-5-8. Museum of Natural History, University of Nevada, Las Vegas.

Elsing, Morris J., and Robert E.S. Heinemen
1936 Arizona Metal Production. Arizona Bureau of Mines Bulletin No. 140, Phoenix.

Euler, Robert C.
1956 Ethnohistory of the Southern Paiute. Ms. prepared for the Department of Justice, on file, Northern Arizona University Special Collections Library, Flagstaff.

1958 Walapai Culture History. Ph.D. dissertation, Department of Anthropology, University of New Mexico. University Microfilms, Ann Arbor.

Euler, Robert C.
1962 Review of The Archaeological Excavations at Willow Beach, Arizona, 1950 by Albert Schoeder, University of Utah Anthropological Papers No. 50. American Antiquity 28:114-115.

1963 Archaeological Problems in Western and Northwestern Arizona, 1962. Plateau 35:78-85.

1964 Southern Paiute Archaeology. American Antiquity 29:379-381.

1966 Southern Paiute Ethnohistory. University of Utah Anthropological Papers No. 78. Salt Lake City.

1967a The Canyon Dwellers. The American West 6(2):22-27, 67-71.

1967b Helicopter Archaeology. American West Review 1:24.

1967c Preliminary Report on Archaeological Resources Within the Reservoir Pools of the Proposed Marble Canyon and Hualapai (Bridge Canyon) Dam Sites. Memorandum to the Arizona Academy of Science, March 1. Ms. on file, Museum of Northern Arizona, Flagstaff.

1969 The Canyon Dwellers: Four Thousand Years of Human History in the Grand Canyon. In The Grand Colorado: The Story of the River and Its Canyons, edited by T. H. Watkins, Palo Alto.

Euler, Robert C.
1971 A Prehistoric Pueblo Pottery Cache in Grand Canyon. Plateau 43:176-184.

1972 The Paiute People. Indian Tribal Series, Phoenix.

1974 Future Archaeological Research in the Grand Canyon. Plateau 46:139-48.

1976 Cultural Patterns in the Havasupai Use Lands, Grand Canyon National Park. Ms. on file, National Park Service, Western Archaeological and Conservation Center, Tucson.

1979 Current Anthropological Research, Grand Canyon National Park. In U.S. National Park Service, Proceedings of the First Conference on Scientific Research in the National Parks Vol. 1, pp. 917-920.

1981 Future Investigations of Kayenta Anasazi in Grand Canyon. Paper presented at the Society for American Archaeology meetings, May 1, San Diego.

1983 The Pinto Basin Complex at Grand Canyon, Arizona. The Kiva 49:67-73.

n.d. NA5507, Antelope Cave Catalog Inventory. Manuscript on file, Department of Anthropology, Museum of Northern Arizona, Flagstaff, Arizona.

Euler, Robert C., editor
1984 The Archaeology, Geology and Paleobiology of Stanton's Cave, Grand Canyon National Park, Arizona, edited by Robert C. Euler. Grand Canyon Natural History Association Monograph No. 6, Grand Canyon.

Euler, Robert C., and Susan Chandler
1978 Aspects of Prehistoric Settlement Patterns in Grand Canyon. In Investigations of the Southwestern Anthropolgical Research Group: an Experiment in Archaeological Cooperation, edited by Robert C. Euler and George J. Gumerman, pp. 73-86. Museum of Northern Arizona, Flagstaff.

Euler, Robert C. and George J. Gumerman, editors
1978 Investigations of the Southwestern Anthropological Research Group: An Experiment in Archaeological Cooperation. Museum of Northern Arizona Bulletin 50. Flagstaff.

Euler, Robert C., George J. Gumerman, Thor N.V. Karlstrom, Jeffrey S. Dean, and Richard H. Hevly
1979 The Colorado Plateaus: Cultural Dynamics and Paleoenvironment. Science 205:1089-1101.

Euler, Robert C., A. Trinkle Jones, Richard W. Effland, and Susan M. Chandler
1980 The Archaeology of the North Rim of the Grand Canyon. In U.S. National Park Service, Proceedings of the Second Conference on Scientific Research in the National Parks Vol.1, pp. 391-405.

Euler, Robert C., and Alan P. Olson
1965 Split Twig Figurines from Northern Arizona: New Radiocarbon Dates. Science 148:368-369.

Euler, Robert C., and Walter W. Taylor
1966 Additional Archaeological Data from Upper Grand Canyon: Nankoweap to Unkar Revisited. Plateau 39:26-45.

Evans, Douglas, James Maxon, and Richard Gale
1969 Reconnaissance of the Shivwits Plateau. Ms. on file, National Park Service, Western Archaeological and Conservation Center, Tucson.

Evarts, Hal G.
1924 Report on the Kaibab Deer Herds. Manuscript on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Faegri, Knut, and Johs. Iversen
1975 Textbook of Pollen Analysis. Hafner Press, New York.

Fairley, Helen C, and J. Richard Ambler
1983 Cultural Resources Survey, Grand Canyon Highway, Kaibab Plateau, Arizona. Proposal submitted to the National Park Service, Western Regional Center, San Francisco.

Fairley, Helen C., and Martha M. Callahan
1985 Ceramics. In Archaeological Investigations near Rainbow City, Navajo Mountain, Utah, edited by Phil R. Geib, J. Richard Ambler, and Martha M. Callahan, pp. 259-310. Northern Arizona University Archaeological Report No. 576, Flagstaff.

Fairley, Helen C., Phil R. Geib, and J. Richard Ambler
1984 An Archaeological Survey Along State Highway 67, Jacob Lake to Grand Canyon National Park, Kaibab National Forest, Arizona. Submitted to Federal Highway Administration, Denver. Northern Arizona University Archaeological Report No. 891, Flagstaff.

Fall, P. L., G. Kelso, and V. Markgraf
1981 Paleoenvironmental Reconstruction at Canyon del Muerto, Arizona, Based on Principal-Component Analysis. Journal of Archaeological Science 8:297-307.

Farmer, Malcolm F., and Raymond DeSaussure
1955 Split Twig Figurines. Plateau 27:3-23.

Farnam., Thomas J.
1843 Travels in the Great Western Prairies, The Anahuac and Rocky Mountains, and in the Oregon Territory. Greeley and McElrath, New York.

Farquhar, Francis P.
1953 The Books of the Colorado River and the Grand Canyon: A Selective Bibliography. Glen Dawson, Los Angeles.

Farrow, E.A.
1930 The Kaibab Indians. Utah Historical Quarterly 3:57-59.

Fawcett, Stanley A.
1966 Kaibab: The Vertical; Integration of a Family Lumber Company. Unpublished M.A. thesis, Department of Forestry, Northern Arizona University, Flagstaff.

Fish, Paul, C. Brandon, J. Bynum, S. Fish, R. Hunt, G. McPherson, P. Moberly, and S. Wood
1974 Preliminary Report for Archaeological and Ethnohistorical Phase I Consultation for the Kaiparowits Power Project: Proposed Plant Sites, Impact Study Area, and Proposed Transmission Line Corridors. Submitted by the Museum of Northern Arizona to Southern California Edison Company. Copy on file, Bureau of Land Management, Arizona Strip District, St. George, Utah.

Ford, Richard I.
1972 An Ecological Perspective on the Eastern Pueblos. In New Perspectives of the Pueblos, edited by Alfonso A. Ortiz, pp. 1-18. University of New Mexico Press, Albuquerque.

Foremaster, Florence
1977 History of Albert Charles Foremaster, 1853-1919. Manuscript in the possession of Barbara Price, St. George, Utah.

Foster, James C.
1970 The Deer of the Kaibab: Federal-State Conflict in Arizona. Arizona and the West 12:255-268.

Foster, Lawrence
1982 Polygamy and the Frontier: Mormon Women in Early Utah. Utah Historical Quarterly 50:268-289.

Fowler, Catherine S.
1972 Some Ecological Clues to Proto-Numic Homelands. In Great Basin Cultural Ecology: A Symposium, edited by Don D. Fowler, pp. 105-121. Desert Research Institute Publications in the Social Sciences No. 8. University of Nevada, Reno.

1982 Settlement Patterns and Subsistence Systems in the Great Basin: The Ethnographic Record. In Man and Environment in the Great Basin, edited by David B. Madsen and James F. O'Connell, pp. 121-138. Society for American Archaeology Papers No. 2. Washington, DC.

Fowler, Don D.
1968 Archaeological Survey in Eastern Nevada, 1966. Desert Research Institute Publications in the Social Sciences No. 2. University of Nevada, Reno.

1973 Dated Split Twig Figurine from Etna Cave, Nevada. Plateau 46:54-63.

Fowler, Don D., editor
1972 "Photographed All the Best Scenery": Jack Hiller's Diary of the Powell Expeditions, 1871-1975. University of Utah Press, Salt Lake City.

Fowler, Don D., and C. Melvin Aikens
1963 1961 Excavations, Kaiparowits Plateau, Utah. University of Utah Anthropological Papers No. 66. Salt Lake City.

Fowler, Don D., Robert C. Euler, and Catherine S. Fowler
1969 John Wesley Powell and the Anthropology of the Canyon Country. U.S. Geological Survey Professional Papers 670, Washington, D.C.

Fowler, Don D, and Catherine S. Fowler
1968 John Wesley Powell's Journal: Colorado River Exploration 1871-1872. The Smithsonsion Journal of History. 3(2):1-44.

Fowler, Don D, and Catherine S. Fowler
1969 John Wesley Powell, Anthropologist. Utah Historical Quarterly 37:152-172.

Fowler, Don D. and Catherine S. Fowler, editors
1971a Anthropology of the Numa: John Wesley Powell's Manuscripts on the Numic Peoples of Western North America, 1868-1880. Smithsonian Contributions to Anthropology No. 14, Washington, D.C.

1971b Notes on the History of the Southern Paiutes and Western Shoshonis. Utah Historical Quarterly 39:95-113.

1981 The Southern Paiute: A.D. 1400-1776. In The Protohistoric Period in the North American Southwest, A.D. 1450-1700, edited by David R. Wilcox and Bruce Masse, pp. 129-166. Arizona State University Anthropological Papers No. 24. Tempe.

Fowler, Don D., James H. Gunnerson, Jesse D. Jennings, Robert H. Lister, Dee Ann Suhm, and Ted Weller
1959 The Glen Canyon Archaeological Survey, Parts I-III. University of Utah Anthropological Papers No. 39. Salt Lake City.

Fowler, Don D., David B. Madsen, and Eugene M. Hattori
1973 Prehistory of Southeastern Nevada. Desert Research Institute Publications in the Social Sciences No. 6. University of Nevada, Reno.

Fowler, Don D., and J. F. Matley
1978 Material Culture of the Numa: the Powell Collection from Southern Utah and Northern Arizona, 1868-1880. Smithsonian Contributions to Anthropology No. 26. Washington, D.C.

1979 The Palmer Collection from Southern Utah. University of Utah Anthropological Papers No. 99 (Miscellaneous Collected Papers No. 20), Salt Lake City.

Fowler, Don D., and Floyd W, Sharrock
1973 Survey and Test Excavations. In: Prehistory of Southeastern Nevada. By D.D. Fowler, D.B. Madsen, and E.M. Hahori, pp. 97-136. Desert Research Institute Publications in the Social Sciences No. 6, Reno.

Francaviglia, Richard V.
1970 The Mormon Landscape: Existence, Creation, and Perception of a Unique Image in the American West. Unpublished Ph.D. dissertation, Department of History, University of Oregon.

1978 The Mormon Landscape: Existence, Creation, and Perception of a Unique Image in the American West. AMS, New York.

Fremont, John C.
1845 Report of the Exploring Expedition to the Rocky Mountains in the year 1842 and to Oregon and Northern California in the years 1843-1844. Gales and Seaton Printers, Washington, D.C.

Fritts, Harold C.
1965 Tree-Ring Evidence for Climatic Changes in Western North America. Monthly Weather Review 93(7):421-443

Fritts, Harold C.

1966 Growth Rings of Trees: Their Correlation With Climate. Science 154(3752):973-979.

1971 Dendroclimatology and Dendroecology. Quaternary Research 1:419-449.

1974 Relationships of Ring-widths in Arid-site Conifers to Variations in Monthly Temperatures and Precipitation. Ecological Monographs 44:411-440.

1976 Tree Rings and Climate. Academic Press, London.

1977 Tree Rings: A Record of Climate Past. Environmental Data Service, July, pp. 3-10. U.S. Department of Commerce,

Fritts, Harold C., T. J. Blasing, B. P. Hayden, and J. Kutzback

1971 Multivariate Techniques for Specifying Tree-Growth and Climate Relationships and for Reconstructing Anomalies in Paleoclimate. Journal of Applied Meteorology 10(5):845-864.

Fritts, Harold C., and G. R. Lofgren

1978 Proxy Records of Climatic Variations for the Last 1000 Years. Ms. on file, Laboratory of Tree-Ring Research, University of Arizona, Tucson.

Fritts, Harold C., D. C. Smith, and M. A. Stokes

1965 The Biological Model for Paleoclimatic Interpretation of Mesa Verde Tree-ring Series. American Antiquity 31:101-121.

Fry, Gary Frederic

1970 Prehistoric Human Ecology in Utah: Based on the Analysis of Corprolites. Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City. University Microfilms, Ann Arbor.

Game Management Committee

1930 Report of the Game Management Committee. Ms. on file, R-3 Kaibab File, USDA-Forest Service, Southwest Region Office, Albuquerque.

Gannett, Henry

1894 Triangulation of the Powell Survey. In Results of Primary Triangulation. United States Geological Survey Bulletin No. 122. Government Printing Office, Washinton, D.C.

Geerlings, Paul F.

1973 Down the Grand Staircase: Grand Canyon's Living Adventure. Grand Canyon Publications, Salt Lake City.

Geib, Phil R., and J. Richard Ambler

1983 Late PIII in the Navajo Mountain Area, Southern Utah. Paper presented at the 56th Pecos Conference, Bluff, Utah.

Geib, Phil R., J. Richard Ambler, and Martha M. Callahan

1985 Archaeological Investigations near Rainbow City, Navajo Mountain, Utah. Report submitted to the Bureau of Indian Affairs, Cultural Resource Division, Window Rock, Arizona. Northern Arizona University Report No. 576, Flagstaff.

Geib, Phil R. and Michael J. Bremer
n.d. Prehistory of the Orange Cliffs Tar Sands Triangle and a Model of General Site Location. Northern Arizona Report No. 997, Flagstaff.

Geib, Phil R., Peter Bungart, Helen C. Fairley, and Marietta Davenport
1987 Archaeological Investigations Along the Lower Escalante: Glen Canyon Year 2 (1985-1986) Descriptive Report. Submitted to National Park Service, Rocky Mountain Regional Office, Denver. Northern Arizona University Archaeological Report No. 1000, Flagstaff.

Geib, Phil R., and Martha M. Callahan
1987 Ceramic Exchange Within the Kayenta Anasazi Region: Volcanic Ash-tempered Tusayan White Ware. The Kiva 52:95-112.

Geib, Phil R., Helen C. Fairley, and J. Richard Ambler
1986 Archaeological Research Plan for the Glen Canyon National Recreation Area. Report submitted to the USDI National Park Service, Rocky Mountain Regional Office, Denver. Northern Arizona Universtiy Report No. 998, Flagstaff.

Geib, Phil R., Helen C. Fairley, and Peter Bungart
1986 Archaeological Survey in the Glen Canyon National Recreation Area: Year 1 Descriptive Report, 1984 1985. Submitted to National Park Service, Rocky Mountain Regional Office, Denver. Northern Arizona University Archaeological Report No. 999, Flagstaff.

Geib, Phil R., and Donald R. Keller
1987 The Archaeology and Paleoecology of Bighorn Cave, Black Mountains, Arizona. Paper presented at the Arizona-Nevada Academy of Sciences Meeting, Flagstaff.

Gelpke, Richard Butler
1973 The Mormon Impact on the Arizona Landscape. Unpublished M.A. thesis, University of Arizona, Tucson.

Gery, R. E., and John A. Smith
1915 Report on Lieu Selections on that Portion of Arizona Line North and West of the Colorado River. U. S. Department of Agriculture, U. S. Forest Service, Washington, D.C.

Gilbert, Grove K.
1875 Report on the Geology of Portions of Nevada, Utah, California, and Arizona, Examined in the years 1871 and 1872. In Report upon Geographical and Geological Explorations and Surveys West of the Hundreth Meridian, III: Geology. by Lt. George M. Wheeler. Government Printing Office, Washington, D.C.

1877 Report on the Geology of the Henry Mountains. U.S. Geographical and Geological Survey of the Rocky Mountain Region. Washington, D.C.

1890 Lake Bonneville. Monographs of the U.S. Geological Survey, Vol. 1. Government Printing Office, Washington, D.C.

Gladwin, Winifred, and Harold S. Gladwin
1934 A Method for Designation of Cultures and Their Variations. Medallion Papers No. 15. Gila Pueblo, Globe, Arizona.

Glassow, Michael A.
1972 Changes in the Adaptations of Southwestern Basketmakers: A Systems Perspective. In Contemporary Archaeology, edited by Mark P. Leone. Southern Illinois University Press, Carbondale.

Goetzmann, William H.
1966 Exploration and Empire: The Explorer and the Scientist in Winning the American West. Alfred A. Knopf, New York.

Goldman, E.A., and S.B. Locke
1923 The Mountain of Twenty Thousand Deer. American Forestry 29:649-653, 682.

Goldman, E.A., S.B. Locke, and Ben Swapp
1922 Memorandum Regarding Grand Canyon National Game Preserve, 1922. Ms. on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Goodman, David M.
1969 Arizona Odyssey: Bibliographic Adventures in Nineteenth-century Magazines. Arizona Historical Foundation, Tempe.

Goss, James A.
1965 Ute Linguistics and Anasazi Abandonment of the Four Corners Area. In Contributions of the Wetherill Mesa Archaeological Project, pp. 73-81. Memoirs of the Society for American Archaeology No. 19. Salt Lake City.

1968 Culture-Historical Inference from Utaztekan Linguistic Evidence. In Utaztekan Prehistory. edited by Earl H. Swanson, Jr. Occasional Papers of the Idaho State University Museum No. 22. Pocatello, Idaho.

1977 Linguistic Tools for the Great Basin Prehistorian. In Models and Great Basin Prehistory: A Symposium, edited by Don D. Fowler, pp. 49-70. University of Neveda Desert Research Institute Publications in the Social Sciences 12. Reno.

Goss, Peter L.
1975 The Architectural History of Utah. Utah Historical Quarterly 43:208-239.

Graf, W. L.
1979 Mining and Channel Response. Annals of the Association of American Geographers 69:262-275.

1983 The Arroyo Problem: Paleohydrology and Paleo-Hydraulics in the Short Term. In Background to Paleohydrology, edited by K. J. Gregory, pp. 279-302. John Wiley & Sons, New York.

Granger, Byrd H.
1960 Will C. Barnes' Arizona Place Names, Revised and Enlarged. University of Arizona Press, Tucson.

1983 X Marks the Spot. Falconer Publishing Company, Tucson.

Graybill, Donald A.
1985 Western U. S. Tree Ring Index Chronology Data for Detection of Arboreal Response to Increasing Carbon Dioxide. Department of Energy Report 026, Response of Vegetation to Carbon Dioxide Program. Department of Energy, Washington, D. C.

Gregory, Herbert E.
1950 Geology and Geography of the Zion Park Region, Utah and Arizona. U. S. Geological Survey Professional Paper No. 220.

Gregory, Herbert E., editor
1939 Diary of Almon Harris Thompson. Utah Historical Quarterly 7(1-3):1-140. Salt Lake City.

1948-1949 Journal of Stephen Vandiver Jones. Utah Historical Quarterly 16-17:19-174.

Guernsey, Samuel L., and Alfred V. Kidder
1921 Basketmaker Caves of Northeastern Arizona. Papers of the Peabody Museum of American Archaeology and Ethnology, Vol 12, No. 11. Harvard University, Cambridge.

Gumerman, George J.
1975 Alternative Cultural Models for Demographic Change: Southwestern Examples. In Population Studies in Archaeology and Biological Anthropology: A Symposium, edited by A.C. Swedlund, pp. 104-115. Memoirs of the Society for American Archaeology 30.

Gunnerson, James H.
1959a Archaeological Survey of the Kaiparowits Plateau. In The Glen Canyon Archaeological Survey, Part II, by Don D. Fowler, pp. 318-469. University of Utah Anthropological Papers No. 39. Salt Lake City.

1959b 1957 Excavations, Glen Canyon Area. University of Utah Anthropological Papers 43. Salt Lake City.

1960 Highway Salvage Archeology, St. George, Utah. Special Report to the Utah State Road Commission. University of Utah Anthropological Papers No. 60, pp. 45-66. Salt Lake City.

1962 Plateau Shoshonian Prehistory: A Suggested Reconstruction. American Antiquity 28:41-45.

1969 The Fremont Culture: A Study in Culture Dynamics on the Northern Anasazi Frontier. Papers of the Peabody Museum of American Archaeology and Ethnology Vol. 59, No. 2. Harvard University, Cambridge.

Hack, John T.
1942 The Changing Physical Environment of the Hopi Indians of Arizona. Reports of the Awatovi Expedition, No. 1. Papers of the Peabody Museum of American Archaeology and Ethnology, Vol. 35, No. 1. Harvard University.

Hafen, Leroy R. (editor)
1965 The Mountain Men and the Fur Trade of the Far West: Biographical Sketches. Arthur H. Clark, Glendale, California.

Hafen, Leroy R. and Ann W. Hafen
1954 Old Spanish Trail: Santa Fe to Los Angeles. The Authur H. Clark Company, Glendale, California.

Hague, Harlan
1978 The Road to California: The Search for a Southern Overland Route, 1540-1848. Arthur H. Clark, Glendale, California.

Hale, Kenneth
1958 Internal Diversity in Uto-Aztecan:I. International Journal of American Linguistics 24(2):101-107.

1959 Internal Diversity in Uto-Aztecan:II. International Journal of American Linguistics 25(2):114-121.

Hall, Edward T., Jr.
1942 Archaeological Survey of the Walhalla Glades. Museum of Northern Arizona Bulletin No. 20, Flagstaff.

Hall, Henry J.
1972 Diet and Disease at Clyde's Cavern, Utah, As Revealed via Paleoscatology. Unpublished M.A. thesis, Department of Anthropology, University of Utah, Salt Lake City.

Hall, Robert L., and Arthur E. Dennis
1986 Cultivated and Gathered Plant Foods. In Archaeological Investigations at Antelope House. Edited by Don P. Morris, pp. 110-141. USDI National Park Service, Government Printing Office, Washington, D.C.

Hall, Sharlot
1975 Sharlot Hall on the Arizona Strip: A Diary of a Journey through Northern Arizona in 1911. Edited by Gregory C. Crampton. Northland Press, Flagstaff.

Hall, Stephen A.
1977 Late Quaternary Sedimentation and Paleoecologic History of Chaco Canyon, New Mexico. Geological Society of America Bulletin 88, No. 11.

Hamblin, Jacob
1932 Early Days in Utah's Dixie. Utah Historical Quarterly 5:130-134.

Harrington, Mark R.
1925a An Ancient Salt Mine Near St. Thomas, Nevada. Indian Notes 2:227-231. Museum of the American Indian, Heye Foundation, New York.

1925b Archaeological Researches in Nevada. Indian Notes 1:125-127. Museum of the American Indian, Heye Foundation, New York.

1925c The "Lost City" of Nevada. Scientific American 133:14-16.

1925d A Pueblo Site Near St. Thomas, Nevada. Indian Notes 2:74-76. Museum of the American Indian, Heye Foundation, New York.

Harrington, Mark R.
1926a A Pre-Pueblo Site on the Colorado River. Indian Notes 3:274-284. Museum of the American Indian, Heye Foundation, New York.

1926b Primitive Pueblo Ruin in Northwestern Arizona. Indian Notes 3:172-177. Museum of the American Indian, Heye Foundation, New York.

1926c Western Extensions of the Early Pueblo Culture. Indian Notes 3:69-73. Museum of the American Indian, Heye Foundation, New York.

1927 A Primitive Pueblo City in Nevada. American Anthropologist 29:262-277.

1928 Tracing the Pueblo Boundary in Nevada. Indian Notes 5:235-240. Museum of the American Indian, Heye Foundation, New York.

1929 Dead Men Tell Tales. Masterkey 3:29-30.

1930a Archaeological Field Work in North America During 1929: Nevada. American Anthropologist 32:357-358.

1930b The Southwest Museum's 1929 Survey of the Lower Moapa Valley. Ms. on file, Southwest Museum, Los Angeles.

1930c Introduction. In Archaeological Explorations in Southern Nevada, by Mark R. Harrington, pp. 1-25, Southwest Museum Papers 4. Los Angeles.

1930d Paiute Cave. In Archaeological Explorations in Southern Nevada, by Mark R. Harrington, pp. 106-126. Southest Museum Papers 4. Los Angeles.

1933 Gypsum Cave. Southwest Museum Papers No. 8, Los Angeles.

1937a Ancient Nevada Pueblo Cotton. Masterkey 11:5-7.

1937b Excavation of Pueblo Grande de Nevada. Bulletin of the Texas Archaeological and Paleontological Society 9:130-145.

1937c Some Early Pit Dwellings in Nevada. Masterkey 11:122-124.

1937d A Stratified Camp Site Near Boulder Dam. Masterkey 11:86-89.

1942 Black Dog Cave. Masterkey 16:173-174.

1953a Early Pueblo Houses in Southern Nevada. Masterkey 17:203-209.

1953b Southern Nevada Pit Dwellings. Masterkey 17:136-142.

1957 A Pinto Site at Little Lake, California. Southwest Museum Papers No. 17. Los Angeles.

Harrington, Mark R., Irwin Hayden, and Louis Schellbach
1930 Archaeological Explorations in Southern Nevada. Southwest Museum Papers No. 4. Los Angeles.

Harrison, Clifford D., editor
1941 The Ashley-Smith Explorations and the Discovery of a Central Route to the Pacific, 1822-1829. Arthur H. Clark, Glendale, California.

Haskell, John L.
1978 The Paria Plateau Survey. Report of the 1967 Season Archaeological Inventory of Indian Ruins Located in Coconino County for the Bureau of Land Management. Western Anasazi Reports 1:251-274. Cedar City, Utah.

Haskett, Bert
1936 History of the Sheep Industry in Arizona. Arizona Historical Review 8(3):4-49.

Hassan, Fekri A.
1981 Demographic Archaeology. Academic Press, New York.

Hauck, F.R.
1979a Cultural Resource Evaluation in Central Utah 1977. Bureau of Land Management, Utah, Cultural Resources Series No. 3, Salt Lake City.

1979b Cultural Resource Evaluation in South Central Utah 1977-1978. Bureau of Land Management, Utah, Cultural Resources Series No. 4, Salt Lake City.

Haury, Emil
n.d. Archaeology of the North Rim. Gila Pueblo files, on file at the Arizona State Museum archives, Tucson.

1931 Kivas of the Tusayan Ruin, Grand Canyon, Arizona. Medallion Papers No. 9. Gila Pueblo, Globe, Arizona.

Hayden, Irwin
1930 Mesa House. Southwest Museum Papers, No. 4, Pt. 2. Los Angeles.

Haynes, C. Vance, Jr.
1969 The Earliest Americans. Science 166:709-715.

1971 Time, Environment, and Early Man. Arctic Anthropology 8:3-14.

Heath, Kathleen N.
1986 Seeds of Change: Macrofossil Analysis and Interpretation from Quail Creek. Appendix III. In Excavations at Quail Creek, by Barbara A. Walling, Richard A. Thompson, Gardiner F. Dalley, and Dennis G. Weder, Kathleen M. Heath and La Mar W. Lindsay, pp. 477-498. Bureau of Land Management, Utah, Cultural Resources Series No. 20. Salt Lake City.

Heede, B. H.
1976 Gully Development and Control: the Status of Our Knowledge. U.S. Forest Service Research Paper RM-169.

Hegemann, Elizabeth Compton
1963 Navajo Trading Days. University of New Mexico Press, Albuquerque.

Heid, James L.
1982 Settlement Patterns on Little Creek Mountain, Utah. Western Anasazi Reports 3(2). Cedar City.

Heid, James L., Claude N. Warren, and Patricia Rocchio
1979 The Western Pluvial Lake Tradition: A Critique. Paper presented at the Society for California Archaelogy Conference, April 5-7, 1979, San Luis Obispo, California.

Heizer, Robert F.
1954 Notes on the Utah Utes, by Edward Palmer, 1866-1877. University of Utah Anthropological Papers No. 17. Salt Lake City.

1970 A Mescal Knife from Near Overton, Moapa Valley, Southern Nevada. University of California Archaeological Research Facility Contributions No. 7, pp. 28-38. Berkeley.

Heizer, Robert F., and Martin A. Baumhoff
1961 The Archaeology of Two Sites at Eastgate, Churchill County, Nevada: Wagon Jack Shelter. University of California Anthropological Records 20(4): 119-149.

1962 Prehistoric Rock Art of Nevada and Eastern California. University of California Press, Berkeley.

1970 Big Game Hunters in the Great Basin: A Critical Review of the Evidence. Contributions of the University of California Anthropological Research Facility 7:1-12. Berkeley.

Heizer, Robert F. and R. Berger
1970 Radiocarbon Age of the Gypsum Culture. University of California Archaeological Research Facility, Contributions 7:13-18. Berkeley.

Hereford, Richard
1984 Climate and Ephemeral Stream Processes, Twentieth Century Geomorphology and Alluvial Stratigraphy of the Little Colorado River, Arizona, Geological Society of America Bulletin 95:654-668.

1986 Modern Alluvial History of the Paria River Drainage Basin, Southern Utah. Quaternary Research 25:293-311.

Hester, Thomas R.
1973 Chronological Ordering of Great Basin Prehistory. Contributions of the University of California Archaeological Research Facility No. 17. Berkeley.

Hester, Thomas R., and Robert F. Heizer
1973 Review and Discussion of Great Basin Projectile Points: Forms and Chronology. Contributions of the University of California Archaeological Research Facility No. 18. Berkeley.

Hevly, Richard H.
1964 Pollen Analysis of Quaternary Archaeological and Lacustrine Sediments on the Colorado Plateau. Ph.D. dissertation, Department of Botany, University of Arizona.

1981 Pollen Production, Transport, and Preservation: Potentials and Limitations in Archaeological Palynology. Journal of Ethnobiology 1:39-55.

1984 Plant Pollen from Human Feces, Dust Devil Cave. Paper presented at the 19th Biennial Great Basin Anthropological Conference, Boise, Idaho.

Hevly, Richard H. and Karl J. Reinhard
1984 Phytoliths from Dust Devil Cave Feces. Paper presented at the 19th Biennial Great Basin Anthropological Conference, Boise, Idaho.

Hevly, Richard H., and L. E. Renner
1980 Pollen,Spores and Other Atmospheric Particulates. Museum of Northern Arizona Research Report 18. Flagstaff, Arizona.

Hewitt, Nancy J.
1980 Fiber Artifacts. In Cowboy Cave, by Jesse D. Jennings, pp. 49-96. University of Utah Anthropological Papers No. 104. Salt Lake City.

Hill, Joseph J.
1930 Spanish and Mexican Exploration and Trade Northwest from New Mexico into the Great Basin. Utah Historical Quarterly 3:2-23.

Hinton, Wayne K.
1987 The Dixie National Forest: Managing an Alpine Forest in an Arid Setting., U.S. Department of Agriculture, Intermontane Region, Dixie National Forest, Cedar City, Utah.

Hirth, Kenneth
1978 Interregional Trade and the Formation of Prehistoric Gateway Communities. American Antiquity 43:35-44.

Hobler, Phillip M. and Audrey E. Hobler
1978 An Archaeological Survey of the Upper White Canyon Area, Southeastern Utah. Antiquities Section Selected Papers 5(13). Utah State Historical Society, Salt Lake City.

Hodder, Ian
1978 Simple Correlations between Material Culture and Society. In The Spatial Organization of Culture, edited by Ian Hodder, pp. 3-25. Duckworth, London.

1982 Symbols in Action. Cambridge University Press, New York.

Hodgin, F. M.
1962 History of the North Kaibab, Kaibab National Forest. Ms. on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Hoffman, Walter J.
1878 Miscellaneous Ethnological Observations on Indians Inhabiting Nevada, California and Arizona. In 10th Annual Report on the U.S. Geological and Geographical Survey of the Territories for the Year 1876, edited by F.V. Hayden, pp. 461- 478. U.S. Government Printing Office, Washington, D.C.

Hoffmeister, Donald F., and Floyd E. Durham
1971 Mammals of the Arizona Strip, including Grand Canyon National Monument. Museum of Northern Arizona Technical Series No. 11, Flagstaff.

Hogan, Patrick F.
1980 The Analysis of Human Coprolites from Cowboy Cave. Appendix. IX. In Cowboy Cave. Edited by Jesse D. Jennings, pp. 201-212. University of Utah Anthropological Papers No. 104, Salt Lake City.

Holmer, Richard N.
1978 A Mathematical Typology for Archaic Projectile Points of the Eastern Great Basin. Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City. University Microfilms, Ann Arbor.

1979 Archaeological Survey of Exxon Mineral Leases in the Lake Mead National Recreation Area. Western Anasazi Reports 2:3-38.

1980 Projectile Points. In Sudden Shelter, by Jesse D. Jennings, Alan R. Schroedl, and Richard N. Holmer, pp. 63-83. University of Utah Anthropological Papers No. 103. Salt Lake City.

1986 Common Projectile Points of the Intermountain West. In Essays in Honor of Jesse D. Jennings, edited Carol J. Condie and Don D. Fowler, pp. 89-115. University of Utah Anthropological Papers No. 110. Salt Lake City.

Holmer, Richard N., and Dennis G. Weder
1980 Common Post Archaic Projectile Points of the Fremont Area. In Fremont Perspectives, edited by David B. Madsen. Utah State Historical Society Antiquities Section Selected Papers 7(16). Salt Lake City.

Holmes, William H.
1886 Pottery of the Ancient Pueblos. In 4th Annual Report of the Bureau of American Ethnology for the Years 1882 1883, pp. 257-360. U.S. Government Printing Office, Washington, D.C.

Hooper, Mildred, and C. R. Hooper
1977a The Lore of Houserock Valley. Outdoor Arizona 49(8):16-21,77.

1977b Part I: Arizona Strip Country. Outdoor Arizona 49(10).

1977c Part II: Arizona Strip Country. Outdoor Arizona 49(11):18-21.

Horn, Lyle H., Reid A. Bryson, and William P. Lowry
1957 An Objective Precipitation Climatology of the United States. University of Wisconsin Department of Meteorology, Madison, Wisconsin. U.S.A.F. Contract AF 19 (604) 992.

House, Dorothy A.
1986 Under Vermilion Cliffs: Man on the Arizona Strip. Plateau:22-30.

Huber, Edgar
1982 An Archaeological Survey of 101 Kilometers of Seismic Lines in Mohave County, Arizona. Report on file, U.S. Department of Interior, Bureau of Land Management, Arizona Strip District Office, St. George, Utah.

Huckell, Bruce B.
1982 The Distribution of Fluted Points in Arizona: A Review and Update. Arizona State Museum, Cultural Resource Division, Archaeological Series No. 145. Tucson.

Hughes, J. Donald.
1978 In the House of Stone and Light: A Human History of the Grand Canyon. Grand Canyon Natural History Association, Grand Canyon.

Hulbert, Archer Butler
1933 Southwest on the Turquoise Trail. Arthur H. Clark, Glendale, California.

Hunt, Alice B.
1960 Archaeology of the Death Valley Salt Pan, California. University of Utah Anthropological Papers 47. Salt Lake City.

Hunt, Roy D.
1978 An Historical Sketch of the Mount Trumbull Sawmill Sites. Western Anasazi Reports 1:240-243.

Hunt, Roy D., and Gale M. McPherson
1975 Preliminary Report for Archaeological and Ethnohistorical Phase I Investigations on Proposed Arizona Strip Alternate Transmission Line Corridor. Ms. on file Museum of Northern Arizona, Flagstaff.

Hurlbett, R. E.
1976 Environmental Constraints and Settlement Predictability, Northwestern Colorado. Bureau of Land Management, Colorado, Cultural Resource Series No.3. Denver.

Hurt, Garland
1876 Indians of Utah. IN Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon-Route from Camp Floyd to Genoa, in Carson Valley in 1859. Edited by Capt. James H. Simpson, pp. 459-464. U.S. Government Printing Office, Washington, D.C.

Irwin-Williams, Cynthia
1967 Picosa. The Elementary Southwestern Culture. American Antiquity 32:441-452.

1973 The Oshara Tradition: Origins of Anasazi Culture. Eastern New Mexico Contributions in Anthropology 5(1).

1979 Post-Pleistocene Archaeology, 7000-2000 B.C.. In Handbook of North American Indians, Vol. 9, Southwest. Edited by Alfonso Ortiz, pp. 31-42. Smithsonian Institution. Washington, D.C.

Irwin-Williams, Cynthia, and C. Vance Haynes, Jr.
1970 Climatic Change and Early Population Dynamics in the Southwestern United States. Quaternary Research 1:59-71.

Irwin-Williams, Cynthia, Henry T. Irwin, George Agogino, and C. Vance Haynes, Jr.
1973 Hell Gap: Paleo-Indian Occupation on the High Plains. Plains Anthropologist 18(59):40-53.

Ives, Joseph C.
1861 Report upon the Colorado River of the West, Explored in 1857 and 1858. U.S. 36th Congress, 1st Session, House Ex. Document No. 90. U.S. Government Printing Office, Washington, D.C.

Jack, Jennifer L.
1986 Paria Plateau Patrol Plan. Ms. on file, Bureau of Land Management, Arizona Strip District, St. George, Utah.

Jackson, Richard H., editor
1978 The Mormon Role in the Settlement of the West. Brigham Young University Press, Provo.

James, Altus, and Ralph Button
n.d. Notes from an Interview. Copy on file, Fredonia Public Schools Manuscript Collection, No.161, Northern Arizona University Special Collections Library, Flagstaff.

James, Charles D.
1974 Final Report for Archaeological Appraisal of Short Creek Reservoir No. 1. Ms. on file, Department of Anthropology, Museum of Northern Arizona, Flagstaff.

Janetski, Joel C.
1986 A Proposal for Archaeological Research at Antelope Cave (NA 5507), Arizona. Ms. on file, Bureau of Land Management, St. George, Utah.

Janetski, Joel C., and Michael J. Hall
1983 An Archaeological and Geological Assessment of Antelope Cave (NA5507), Mohave County, Northwestern Arizona. Submitted by Cultural Resource Management Services, Department of Anthroplogy, Brigham Young University to Bureau of Land Management, Arizona Strip District, St. George, Utah.

Jelinek, Arthur J.
1966 Correlation of Archaeological and Palynological Data. Science 152:1507.

Jenkins, Dennis L.
1981 Cliff's Edge: A Pueblo I Site on the Lower Virgin River. Unpublished M.A. thesis, Department of Anthropology, University of Nevada, las Vegas.

Jennings, Calvin H.
1978 An Archaeological Reconnaissance in the Paria Canyon, Arizona-Utah, 1967. Western Anasazi Reports 1:23-32. Cedar City, Utah.

Jennings, E. P.
1904 The Copper Deposits of the Kaibab Plateau, Arizona. Transactions of the American Institute of Mining Engineers 34:839-841.

Jennings, Jesse D.
1957 Danger Cave. University of Utah Anthropological Papers No. 27, Salt Lake City.

1964 The Desert West. In Prehistoric Man in the New World. Edited by Jesse D. Jennings and Edward Norbeck. University of Chicago Press, Chicago.

1966 Glen Canyon: A Summary. University of Utah Anthropological Papers No. 81. Salt Lake City.

1974 Prehistory of North America (2d edition). McGraw Hill, New York.

1980 Cowboy Cave. University of Utah Anthropological Papers No. 104, Salt Lake City.

Jennings, Jesse D., and Edward Norbeck

1955 Great Basin Prehistory: A Review. American Antiquity 21:1-11.

Jennings, Jesse D., Alan R. Schroedl, and Richard N. Holmer

1980 Sudden Shelter. University of Utah Anthropological Papers No. 103. Salt Lake City.

Jennings, W. P.

1911 Grand Gulch Copper Mine. Mining and Scientific Press February 18, 1911:102,269.

Jenson, Andrews

1941 Encyclopedic History of the Church of Jesus Christ of Latter-Day Saints. Deseret News, Salt Lake City.

Jochim, M. A.

1976 Hunter gatherer Subsistence and Settlement: A Predictive Model. Academic Press, New York.

1981 Strategies for Survival. Academic Press, New York.

Johnson, Keith L.

1959 Antelope Cave: A Basketmaker-Pueblo Site in the Arizona Strip. In Abstracts of the 6th Great Basin Archaeological Conference, September 10-11, 1959, Santa Barbara, California. Mimeograph on file, Museum of Northern Arizona, Flagstaff.

Johnson, Keith L., and David M. Pendergast

1960 Archaeological Exploration of Antelope Cave, Arizona. Preliminary report submitted by the Department of Anthropology and Sociology, University of California, Los Angeles to the Secretary of the Smithsonian Institution. (Reprinted as Appendix 4 in An Archaeological and Geological Assessment of Antelope Cave (NA5507), Mohave County, Northwestern Arizona, by Joel C. Janetski and Michael J. Hall).

Jones, Anne Trinkle

1986a Agricultural Systems at Grand Canyon: Walhalla Glades. Western Anasazi Reports 3:405-441.

1986b A Cross Section of Grand Canyon Archaeology: Excavations at Five Sites Along the Colorado River. Western Archaeological and Conservation Center Publications in Anthropology No. 28. Tucson.

1986c Spatial and Temporal Variation in Grand Canyon Subsistence and Technology. Western Anasazi Reports 3:260-271. Cedar City, Utah.

Jones, Volney H.

1948 Notes of Frederick S. Dellenbaugh on the Southern Paiutes from Letters of 1927 and 1928. Masterkey 22:177-183.

Jorde, L. B.

1977 Precipitation Cycles and Cultural Buffering in the Prehistoric Southwest. In For Theory Building in Archaeology, edited by Lewis R. Binford, pp. 385-395. Academic Press, New York.

Judd, Dart
1975 Early History of Fredonia. Copy on file, Fredonia Public School Manuscript Collection No. 161, Northern Arizona University Special Collections Library, Flagstaff.

n.d. Minutes of the Stewart Company. Copy on file, Fredonia Public School Manuscript Collection No. 161, Northern Arizona University Special Collections Library, Flagstaff.

Judd, Neil M.
1918 Archaeological Work in Arizona and Utah. Smithsonian Miscellaneous Collections, Vol. 68, No. 12. Washington, D.C.

1919 Archaeological Reconnaissance of North Western Arizona. Smithsonian Miscellaneous Collections, Vol. 70, No. 1. Washington, D.C.

1921 Archaeological Investigations in Utah and Arizona. Smithsonian Miscellaneous Collections, Vol. 72, No. 1. Washington, D.C.

1926 Archaeological Observations North of the Rio Colorado. Bureau of American Ethnology, Bulletin No. 82. Washington, D.C.

Judge, W. James and Lynne Sebastian, editors
1988 Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling. Bureau of Land Management, Denver.

Kane, Elizabeth Wood
1974 Twelve Mormon Homes: Visited in Succession on a Journey through Utah to California. University of Utah Press, Salt Lake City.

Kappler, Charles J., compiler
1904 Indian Affairs, Laws and Treaties, Vol. I. 63rd Congress, 2nd Session, Senate Document 719. Government Printing Office, Washington, D.C.

Karlstrom, Eric
1986 Physiographic Context for Three Archaeological Sites. In A Cross Section of Grand Canyon Archaeology: Excavations at Five Sites Along the Colorado River, edited by Ann Trinkle Jones, pp. 13-34. USDI National Park Service, Western Archaeological and Conservation Center Publications in Anthropology No. 28.

Karlstrom, Thor N. V.
1978 Stratigraphy and Paleoclimate of the Black Mesa Basin, In The Energy Lands Program of the U.S. Geological Survey Fiscal Year 1976, compiled by J. O. Mayberry, pp. 18-22, U.S. Geological Survey Circular No. 778.

Karlstrom, Thor N. V., George J. Gumerman, and Robert C. Euler
1976 Paleoenvironmental and Cultural Correlates in the Black Mesa Region. In Papers on the Archaeology of Black Mesa, Arizona, edited by George J. Gumerman and Robert C. Euler, pp. 149-161. Southern Illinois University Press, Carbondale.

Keller, Donald R.
1975 Preliminary Report for Water and Sewer Facilities Archaeological Survey on the Kaibab Reservation. Ms. on file, Department of Anthropology, Museum of Northern Arizona, Flagstaff.

Keller, Donald R.
1978a Archaeological Clearance Survey of 21.3 Miles of Proposed Water Pipeline, Cedar Ridge to Bitter Springs, Arizona. Report prepared for Public Health Service, Navajo Area Office, Navajo Indian Reservation, Coconino County, Arizona.

1978b Final Report for an Archaeological Survey of 9.9 Miles of Stock Water Pipeline Alignment, Riggs Spring to Kanab Creek, Kaibab Paiute Indian Reservation. Ms. on file, Department of Anthropology, Museum of Northern Arizona, Flagstaff.

1979a Final Report for Archaeological Survey of a 15 acre Reservoir Area at Colorado City, Mohave County, Arizona. Ms. on file, Department of Anthropology, Museum of Northern Arizona, Flagstaff.

1979b Final Report for an Archaeological Survey of a 100 Acre and a 40 acre Area Proposed for Sprinkler Irrigation Agricultural Development, Kaibab Paiute Indian Reservation. Ms. on file, Department of Anthropology, Museum of Northern Arizona, Flagstaff.

Kelly, Charles, editor
1948-1949 Journal of Walter Clement Powell. Utah Historical Quarterly 16-17:257-478.

Kelly, Isabel T.
1934 Southern Paiute Bands. American Anthropologist 36:548-560.

1939 Southern Paiute Shamanism. University of California Anthropological Records 2(4):151-57. Berkeley.

1964 Southern Paiute Ethnography. University of Utah Anthropological Papers No. 69. Salt Lake City.

Kelly, Isabel T., and Catherine S. Fowler
1986 Southern Paiute. In Handbook of North American Indians, Vol. II, Great Basin. Edited by Warren L. D'Azevedo, pp. 368-397. Smithsonian Institution, Washington, D.C.

Kelly, Robert L.
1983 Hunter-gatherer Mobility Strategies. Journal of Anthropological Research 39:277-306.

Kelly, Roger E.
1971 Fourteen Prehistoric Sites in Nankoweap Canyon, Grand Canyon National Park. The Arizona Archaeologist 3:17-35.

Kelso, Gerald K.
1972 Two Pollen Profiles from Grasshopper Ruin and the Little Colorado Pollen Sequence. MS on file, Department of Anthropology, University of Arizona, Tucson.

1981 Palynology and Human Paleoecology in Dead Valley. Arizona State Museum Publication, Tucson, Arizona.

Kemrer, Meade F.
1971 Tree Rings as Indicators of Intra-Annual Climate. 1968-1969 and 1969-1970 Annual reports to the National Park Service, Department of the Interior, Washington D.C. Laboratory of Tree-Ring Research, The University of Arizona, Tucson, Arizona.

Kemrer, Meade F.
1974 The Dynamics of Western Navajo Settlement, A.D. 1750-1900: An Archaeological and Dendrochronological Analysis. Ph.D. dissertation, University of Arizona, Tucson. University Microfilms, Ann Arbor.

Kent, Kate Peck
1983 Prehistoric Textiles of the Southwest. School of American Research, Santa Fe.

Keyser, James D.
1985 Introduction. In Archaeological Inventory and Predictive Modelling in the Pacific Northwest, edited by Richard F. Darsie, James D. Keyser, and Stephen Hackenberger, pp. 1-2. Studies in Cultural Resource Management 6. United States-Forest Service, Pacific Northwest Region. Portland, Oregon.

Kidder, Alfred V.
1910 Explorations in Southwestern Utah in 1908. American Journal of Archaeology, 2nd Series, Vol. 14:337-60. Norwood.

1927 Southwestern Archaeological Conference. Science 68:489-491.

1936 The Archaeology of Peripheral Regions. Southwestern Lore 2(3):46-48.

Kidder, Alfred V., and Samuel J. Guernsey
1919 Archaeological Exploration in Northeastern Arizona. Bureau of American Ethnology Bulletin No. 65. Washington, D.C.

King, Chester
1979 Beads and Selected Ornaments. In Archaeological Studies at Oro Grande, Mohave Desert, California, edited by Carol H. Rector, James D. Swensen, and Philip J. Wilke. Report on file, Archaeological Research Unit, University of California, Riverside.

Klesert, Anthony L.
1979 Black Mesa Culture History and Research Design. In Excavation on Black Mesa, 1978: A Descriptive Report, edited by Anthony L. Klesert and Shirley Powell. Center for Archaeological Investigations Research Paper 8. Southern Illinois University, Carbondale.

Knack, Martha C.
1980 Life is with People: Household Organization of the Contemporary Southern Paiute Indians. Ballena Press Anthropological Papers No. 19, Socorro, California.

Kohler, Timothy, Thomas P. Des Jeans, Carl Feiss, and Don E. Thompson
1980 An Archaeological Survey of Selected Areas of Fort Benning Military Reservation, Alabama and Georgia. Remote Sensing Analysts, Tucker, Georgia. In Fulfillment of Contract C-5716(78), National Park Service, Southeast Region, Interagency Archaeological Services.

Krenkel, John H.
1970 The Life and Times of Joseph Fish, Mormon Pioneer. Interstate Printers and Publishers, Danville, Illinois.

Kroeber, Alfred L.
1935 Walapai Ethnography. Memoirs of the American Anthropological Association No. 42.

Kroeber, Alfred L.
1939 Cultural and Natural Areas of Native North America. University of California Publications in American Archaeology and Ethnology 38(1):1-242. Berkeley.

Kummel, B., and D. Raup
1965 Handbook of Paleontological Techniques. W. H. Freehan, San Francisco.

Kvamme, Kenneth L.
1983 A Manual for Predictive Site Location Models: Examples from the Grand Junction District, Colorado. Bureau of Land Management, Grand Junction, Colorado. Draft copy.

1988 Using Existing Data for Model Building. In Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling, edited by W. James Judge and Lynne Sebastian. Bureau of Land Management, Denver.

Lacy, Leslie Alexander
1976 The Soil Soldiers: The Civilian Conservation Corps in the Great Depression. Chilton, Radnor, Pennsylvania.

Lafferty, Robert H. III, Jeffrey L. Otinger, Sandra Clements Scholtz, W. Fredrick Limp, Beverly Watkins, and Robert D. Jones
1981 Settlement Predictions in Sparta: A Location Analysis and Cultural Resource Assessment in the Uplands of Calhoun County, Arkansas. Arkansas Archeological Survey Research Series 14. Fayetteville.

Lamar, Howard
1960 Political patterns in New Mexico and Utah Territories. Utah Historical Quarterly 28:363-387.

1966 The Far Southwest: A Territorial History. Yale University Press, New Haven.

Lamb, Sidney M.
1958 Linguistic Prehistory in the Great Basin. International Journal of American Linguistics 24(2):95-100.

Lang, D. M., and S. S. Stewart
1910 Reconnaissance of the Kaibab National Forest. Ms. on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Lange, Richard C., and Barbara Murphy
1982 Archaeological Surveys of the Proposed Hack Canyon and Pigeon Canyon Mine Powerline Rights of way in Mohave and Coconino Counties, Arizona, for Garkane Power Association, Inc. and Energy Fuels Nuclear, Inc.: A Final Report. Report on file, Arizona State Museum, Tucson.

Lanner, Ronald M.
1981 The Pinon Pine: A Natural and Cultural History. University of Nevada Press, Reno.

Larson, Andrew Karl
1961 I was Called to Dixie: The Virgin River Basin--Unique Experiences in Mormon Pioneering. Deseret News, Salt Lake City.

Larson, Daniel O.
1981 A Study of Settlement Patterns of Southern Nevada as Reflected by the Archaeological Record. Western Anasazi Reports 3(1).

1983 A Proposal for an Intensive Archaeological Inventory along the Muddy and Virgin Rivers in Southern Nevada. Ms. on file, USDI Bureau of Land Management, Las Vegas District.

1986a Cultural Change Among the Virgin Branch Anasazi. Paper presented at the 1986 Great Basin Conference.

1986b Cultural Change Among the Virgin Branch Anasazi. Unpublished Ph.D. Dissertation, Department of Anthropology, University of California, Santa Barbara.

1987 An Economic Analysis of the Differential Effects of Population Growth and Climatic Variability Among Hunters and Gatherers and Food Producers. Unpublished Ph.D. Dissertation, Department of Anthropology, University of California, Santa Barbara.

Larson, Daniel O., and Katheryne Olson
1984 A Refined Ceramic Chronology for the Southern Great Basin, Paper presented at the XIXth Great Basin Conference, Boise.

Lauritzen, Jonreed
1951 Arizona Strip, the Lonesome Country. Arizona Highways 27:16-25.

Lavender, David
1982 Colorado River Country. E. P. Hutton, New York.

1984 Pipe Spring and the Arizona Strip. Zion Natural History Association, Springdale, Utah.

Layton, Thomas N.
1970 High Rock Archaeology: An Interpretation of the Prehistory of the Northwestern Great Basin. Unpublished PhD. dissertation, Department of Anthropology, Harvard University, Cambridge.

1972 Lithic Chronology in the Fort Rock Valley, Oregon. Tebiwa 15:1-21.

Lee, Lawrence B.
1962 The Homestead Act: Vision and Reality. Utah Historical Quarterly 30:215-234.

Leigh, Rufus Wood
1961 Naming the Green, Sevier and Virgin Rivers. Utah Historical Quarterly 24:137-147.

Leonard, N. Nelson III, and Christopher E. Drover
1980 Prehistoric Turquoise Mining in the Halloran Spring District, San Bernardino County, California. Journal of California and Great Basin Anthropology 2:245-256.

Leone, Mark P.
1972 The Evolution of Mormon Culture in Eastern Arizona. Utah Historical Quarterly 40:122-141.

Leopold, L. B., E. B. Leopold and F. Wendorf

1963 Some Climatic Indicators in the Period A.D. 1200-1400 in New Mexico. UNESCO les Changements de Climat, Paris.

1987 Obsidian Studies on the Coconino Plateau. Paper presented at the Museum of Northern Arizona's 40th Annual Symposium on Southwestern Geology and Paleontology, Flagstaff.

Lepofsky, D.

1986 Preliminary Analysis of Flotation Samples from the Turkey Pen Ruin, Cedar Mesa, Utah. Ms. on file, Laboratory of Archaeology, University of British Columbia.

Lesko, Lawrence M.

1987 Obsidian Studies on the Coconino Plateau. Paper presented at the Museum of Northern Arizona's 40th Annual Symposium on Southwestern Geology and Paleontology, September 17, 1988. Flagstaff.

Lightfoot, Kent G.

1978 Food Redistribution in the Prehistoric Southwest. Paper presented at the 43rd Annual Meeting of the Society for American Archaeology, Tucson.

1986 Regional Surveys in the Eastern United States: The Strengths and Weaknesses of Implementing Subsurface Testing Programs. American Antiquity 51:484-504.

Lightfoot, Kent G. and Gary M. Feinman

1982 Social Differentiation and Leadership Development in Early Pithouse Villages in the Mogollon Region of the American Southwest. American Antiquity 47:64-86.

Lindsay, Alexander J., Jr.

1961 The Beaver Creek Agricultural Community on the San Juan River, Utah. American Antiquity 27:245-249.

1969 The Tsegi Phase of the Kayenta Cultural Tradition in Northeastern Arizona. Ph.D. Dissertation, Department of Anthropology, University of Arizona. University Microfilms, Ann Arbor.

Lindsay, Alexander J., Jr., J. Richard Ambler, Mary Ann Stein, and Phillip M. Hobler

1968 Survey and Excavations North and East of Navajo Mountain, Utah, 1959-1962. Museum of Northern Arizona Bulletin No. 45. Flagstaff.

Lindsay, Lamar W.

1986 Quail Creek Archaeology: The Pollen Study, Appendix II. In Excavations at Quail Creek. Edited by Barbara A. Walling, pp. 449-476. USDI Bureau of Land Management, Utah, Cultural Resource Series No. 20, Salt Lake City.

Lindsay, Lamar, and Rex E. Madsen

1978 Report of Archaeological Surveys of the Pipe Springs National Monument Water Supply Project. Western Anasazi Reports 1:55-60. Cedar City, Utah.

Lingenfelter, Richard E.

1958 First Through the Grand Canyon. Glen Dawson, Los Angeles.

Lipe, William D.

1960 1958 Excavations, Glen Canyon Area. University of Utah Anthropological Papers No. 44. Salt Lake City.

1967 Anasazi Culture and its Relationship to the Environment in the Red Rock Plateau Region, Southwestern, Utah. Ph.D. Dissertation, Anthropology Department, Yale University. University Microfilms, Ann Arbor.

Lipe, William D., and Alexander J. Lindsay, Jr.

1983 Pueblo Adaptations in the Glen Canyon Region. Paper presented at the Second Anasazi Symposium, Farmington, New Mexico.

Lipe, William D., and Richard A. Thompson

1978 Some Considerations for Assessment of Potential Additions to Grand Canyon National Park. Western Anasazi Reports 1:279-303. Cedar City, Utah.

1979 A Cultural Resource Assessment of the Grand Wash Planning Unit of the Arizona Strip District of the Bureau of Land Management. Western Anasazi Reports 2. Cedar City, Utah.

Lister, Florence C.

1959 Pottery. In The Coombs Site, Part 1, by Robert H. Lister, pp. 68-90. University of Utah Anthropological Papers No. 41. Salt Lake City.

1964 Kaiparowits Plateau and Glen Canyon Prehistory: An Interpretation Based on Ceramics. University of Utah Anthropological Papers No. 71. Salt Lake City.

Lister, Robert H.

1959 The Coombs Site, Part I. University of Utah Anthropological Papers No. 41. Salt Lake City.

Lister, Robert H., J. Richard Ambler, and Florence C. Lister

1960 The Coombs Site, Part 2. University of Utah Anthropological Papers No. 41. Salt Lake City.

Lister, Robert H., and Florence C. Lister

1961 The Coombs Site, Part 3. University of Utah Anthropological Papers No. 41. Salt Lake City.

Little, James A.

1881 Jacob Hamblin: A Narrative of His Personal Experience as a Frontiersman, Missionary to the Indians, and Explorer. Faith Promotions Series, Juvenile Instructor, Church of the Latter Day Saints of Jesus Christ, Salt Lake City.

Locke, S. B.

1920 Memorandum on Kaibab Conditions. Ms. on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Long, Paul V., Jr.

1966 Archaeological Excavations in Lower Glen Canyon, Utah, 1959-1960. Museum of Northern Arizona Bulletin No. 42. Flagstaff.

Long, D. M., and S. S. Stewart

1909 Reconnaissance of the Kaibab National Forest. Ms. on file, Northern Arizona University Special Collections Library.

Love, D. W.

1980 Quaternary Geology of Chaco Canyon, Northwestern New Mexico. Ph.D. dissertation, University of New Mexico, Albuquerque.

Lowie, Robert H.

1924 Notes on Shoshonean Ethnography. Anthropological Papers of the American Museum of Natural History 20(9):185-314. New York.

Lucius, William A.

1980 Bone and Shell Material. In Cowboy Cave, by Jesse D. Jennings, pp. 97-107. University of Utah Anthropological Papers 104. Salt Lake City.

Lyneis, Margaret M.

1981 The Western Anasazi Frontier: Cultural Process Along a Prehistoric Boundary. Paper presented at the 46th Annual Society for American Archaeology meetings, April 30, San Diego.

1984 The Western Anasazi Frontier: Cultural Process along a Prehistoric Boundary. In Exploring the Limits: Frontiers and Boundaries in Prehistory, edited by Suzanne P. DeAtley and Frank J. Findlow. BAR International Series 223. Oxford, England.

1986a Residual Archaeology of the Main Ridge Locality, Pueblo Grande de Nevada. Western Anasazi Reports 3:183-259.

1986b A Spatial Analysis of Anasazi Architecture, A.D. 950-1150, Moapa Valley, Nevada. Kiva 52:53-74.

1987 The Painted Bowls from Adams 2. Ms. on file, Laboratory of Archaeology, University of Nevada, Las Vegas.

Lytle-Webb, Jamie

1975 The Environment of Miami Wash, Gila County, Arizona, A.D. 1100 to 1400. Ph.D. dissertation, Department of Geosciences, University of Arizona, Tucson.

Mace, Will

1940 Letter to Gifford Pinchot. Copy on file, Fredonia Public School Manuscript Collection No. 161, Northern Arizona University Special Collections Library, Flagstaff.

Mackelprang, Gayneld

1952 Historical and Community Resource Materials of Fredonia, Arizona. M. A. Thesis, Northern Arizona University, Flagstaff.

Mackey, James

1977 A Multivariate Osteological Approach to Iowa Culture History. American Journal of Physical Anthropology 46:477-482.

Madsen, David B.

1975 Dating Paiute Shoshoni expansion in the Great Basin. American Antiquity 40:82-86.

Madsen, Rex
1977 Prehistoric Ceramics of the Fremont. Museum of Northern Arizona Ceramic Series No. 6. Flagstaff.

Maher, L. J. Jr.
1972 Absolute Pollen Diagram of Redrock Lake, Boulder County, Colorado. Quaternary Research 2:531-553.

Malach, Roman
1974 Mohave County: Sketches of Early Days. Graphicopy, New York.

1975 The Arizona Strip in Mohave County. Mohave Pioneers Historical Society, Kingman, Arizona.

1981 Northland Pioneers in Mohave County, Kingman. Ms. on file, Museum of Northern Arizona Library, Flagstaff.

Malouf, Carling, and A. Arline Malouf
1945 Effects of Spanish Slavery on the Indians of the Inter-mountain West. Southwestern Journal of Anthropology 1:378-391.

Mann, Walter G.
1941 The Kaibab Deer: A Brief History and the Present Plan of Management. Ms. on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Manners, Robert .A.
1959 Habitat, Technology and Social Organization of the Southern Paiute. America Indigena:179-197.

1974 Paiute Indians Vol 1., Southern Paiute and Chemehuevi: An Ethnohistorical Report. Garland Publishing, Inc. New York.

Marshall, Michael P.
1979 Description of New Ceramic Wares and Types. In Archaeology of the Grand Canyon: The Bright Angel Site, by Douglas W. Schwartz, Michael P. Marshall, and Jane Kepp, pp. 97-104. Grand Canyon Archaeological Series Vol 1. School of American Research, Santa Fe.

1980 Appendix D: Description of the Pottery from Unkar Delta. In Archaeology of the Grand Canyon: Unkar Delta, by Douglas W. Schwartz, Richard C. Chapman, and Jane Kepp. Grand Canyon Archaeological Series Vol. 2. School of American Research, Santa Fe.

Martin, Paul S.
n.d. Correlation of Archaeological and Palynological Data. MS on file, Department of Geosciences, University of Arizona, Tucson.

1963 The Last 10,000 Years: A Fossil Pollen Record of the American Southwest. University of Arizona Press, Tucson.

Martin, Paul S., and William Byers
1965 Pollen and Archaeology at Wetherill Mesa. Memoirs of the Society for American Archaeology 19:122-135.

Martin, Paul S., and Fred T. Plog
1973 The Archaeology of Arizona. Doubleday/Natural History Press, Garden City, New York.

Martin, Paul S., and Floyd W. Sharrock
1964 Pollen Analysis of Prehistoric Human Feces: A New Approach to Ethnobotany. American Antiquity 30:168-180.

Matson, R.G.
n.d. Basketmaker II Anasazi. Draft ms. in possession of author.

Matson, R.G., and Brian Chisholm
1986 Basketmaker II Subsistence: Carbon Isotopes and Other Dietary Indicators from Cedar Mesa, Utah. Paper presented at the 3rd Anasazi Symposium, October 24-25, 1986, Monument Valley, Utah.

May, Dean L.
1977 The Making of Saints: The Mormon Town as a Setting for the Study of Culture Change. Utah Historical Quarterly 45:75-92.

McCarthy, Michael
1978 Historical Analyses from Mount Trumbull Sawmill Sites. Western Anasazi Reports 1:245-247.

McClellan, Carole, and David A. Phillips
1978 Archaeological Survey North of Lake Mead, Arizona: Wahl Yee and Mobil Mineral Leases Final Report. National Park Service, Western Archaeological Center, Tucson.

McCellan, Carole, David A. Phillips, and Michael Belshaw
1980 The Archaeology of Lake Mead National Recreation Area: An Assessment. Western Archaeological Center Publications in Anthropology No. 9. Tucson.

McClintock, James H.
1985 Mormon Settlement in Arizona. University of Arizona Press, Tucson. (Originally printed in 1921 by James H. McClintock)

McDonald, J. E.
1956 Variability of Precipitation in an Arid Region: a Survey of Characteristics for Arizona. Arizona Institute of Atmospheric Physics, Technical Report, Meteorology and Climatology, Arid Regions.

McGregor, John C.
1941 Southwestern Archaeology. John Wiley & Sons, New York.

McGuire, Randall H., and Michael B. Schiffer, editors
1982 Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York.

McIntosh, D. H.
1972 Meteorological Glossary. Chemical Publishing Company, New York.

McKee, Barbara
1933 A Large Cliff Dwelling. Grand Canyon Nature Notes 8(7):198-201.

McKee, Edwin D.
1948 The Canyon Trails. In The Inverted Mountains: Canyons of the West. Edited by Roderick Peattle. Vanguard Press, New York.

McKern, W.C.
1939 The Midwestern Taxonomic Method as an Aid to Archaeological Culture Study. American Antiquity 4.

McNutt, Charles H., and Robert C. Euler
1966 The Red Butte Lithic Sites near Grand Canyon, Arizona. American Antiquity 31:410-419.

McOmie, A.M., C.C. Jacobs, and O.C. Bartlett
1915 The Arizona Strip: Report of a Reconnaissance of the Country North of the Grand Canyon. Arizona State Press, Phoenix.

McPherson, Gale
1978 Ceramic Artifacts. In Archaeological Reconnaissance of Lands Adjacent to Grand Canyon, by George Teague and Carole McClellan, pp. 157-168. National Park Service, Western Archaeological Center, Tucson.

Measles, Evelyn B.
1981 Lee's Ferry: A Crossing on the Colorado. Pruett, Boulder.

Medford, Larry D.
1972 Agricultural Destruction of Archaeological Sites in Northeast Arkansas. In Site Destruction due to Agricultural Practices. Arkansas Archeological Survey, Publications on Archeology, Research Series 3. Fayetteville.

Mehringer, Peter J., Jr.
1967 Pollen Analysis and the Alluvial Chronology. The Kiva 32:96-101.

Mehringer, Peter J., Jr., and Peter E. Wigand
1987 Western Juniper in the Holocene. In Proceedings: Pinyon-Juniper Conference, compiled by Richard Everett, pp. 109-119. Intermountain Research Station General Technical Report INT-215, U.S.D.A., Forest Service.

Meighan, Clement W.
1968 Review of Aikens' Virgin Kayenta Cultural Relationships. American Anthropologist 70(1).

Meinig, D. W.
1965 The Mormon Cultural Realm: Strategies and Patterns in the Geography of the American West. Annals of the Association of American Geographers 55:191-220.

Melton, M. A.
1965 The Geomorphic and Paleoclimatic Significance of Alluvial Deposits in Southern Arizona, U.S.A. Journal of Geology 73:1-38.

Metzger, Todd R. and Susan M. Chandler
1985 Ruins Stabilization Activities in Glen Canyon National Recreation Area: Report of the Year 2 Field Season, 1984-1985. Ms. on file, U.S. Department of the Interior, National Park Service, Midwest Archaeological Center, Lincoln.

Metzger, Todd R., Susan Einiger, and Joan K. Gaunt
1985 The Structural Stabilization of Four Prehistoric Ruins in Glen Canyon National Recreation Area: Report of the Year 1 Field Season, 1983-1984. Ms. on file, U.S. Department of the Interior, National Park Service, Midwest Archaeological Center, Lincoln.

Miller, Blaine A.
1978 Archaeological Survey of Sullivan Canyon and Adjacent Areas, Mohave County, Arizona. Western Anasazi Reports 1:33-54. Cedar City, Utah.

Miller, Wick R.
1966 Anthropological Linguistics in the Great Basin. In The Current Status of Anthropological Research in the Great Basin: 1964. Edited by Warren L. d'Azevedo et al., pp. 75-112. University of Nevada Desert Research Institute Social Sciences and Humanities Publicaiton No. 1, Reno.

Mitchell, J. M. Jr., C. W. Stockton, and D. M. Meko
1979 Evidence of a 22-Year Rhythm of Drought in the Western United States Related to the Hale Solar Cycle Since the 16th Century. In Solar Terrestrial Influences in Weather and Climate, edited by B. M. McCormac and T. A. Selega, pp. 125-143. D. Reidel Publishing Company, Holland.

Mitchell, V. L.
1969 The Regionalization of Climate in the Western United States. Ph.D. dissertation, Department of Meteorology, University of Wisconsin, Madison.

1976 The regionalization of climate in the Western United States. Journal of Applied Meteorology 15:920-927.

Moffitt, Kathleen, and Claudia Chang
1978 The Mount Trumbull Archaeological Survey. Western Anasazi Reports 1:185-250. Cedar City, Utah.

Moffitt, Kathleen, Sandra Rayl, and Michael Metcalf
1978 Archaeological Investigations Along the Navajo McCullough Transmission Line, Southern Utah and Northern Arizona. Museum of Northern Arizona Research Report No. 10. Flagstaff.

Morgan, Dale L.
1940 The State of Deseret. Utah Historical Quarterly 8:65-239.

1953 Jedediah Smith and the Opening of the West. Bobbs-Merrill Co., Indianapolis.

Morgan, Dale L., and Carl I. Wheat
1954 Jedediah Smith and His Maps of the American West. California Historical Society, San Francisco.

Morris, Earl H., and Robert F. Burgh
1954 Basket Maker II Sites Near Durango, Colorado. Carnegie Institution of Washington Publication No. 604. Washington, D.C.

Mueller, James W.
1972 The Use of Sampling in Archaeological Survey. PhD. dissertation, Department of Anthropology, University of Arizona, Tucson.

Mueller, James W., Gregory J. Staley, Gayle G. Harrison, Ronald W. Ralph, Carla A. Sartwell and Ronald P. Gauthier
1968 Paria Plateau Survey Report, 1968 Season. Ms. on file, Museum of Northern Arizona, Flagstaff.

Nabhan, Gary
1985 The Desert Smells Like Rain: A Naturalists in Papago Indian Country. University of Arizona Press, Tucson.

Nabhan, Gary and Paul Mirocha
1986 Gathering the Desert. University of Arizona Press, Tucson.

Nance, Jack D., and Bruce F. Ball
1986 No Surprises? The Reliability and Validity of Test Pit Sampling. American Antiquity 51(3):457-483.

National Park Service
1982 How to Apply the National Register Criteria for Evaluation. National Park Service, Washington, D.C., Draft copy.

Native Seeds/SEARCH
n.d.a. Southwestern Corn Bibliography, Publication PB21. Native Seeds/SEARCH, Tucson.

n.d.b. Wild Cucurbita of Arid America: An Annotated Bibliography of Ethnic Uses, Chemistry and Geography. Native Seeds/SEARCH, Tucson.

1988 1988 Seedlisting. Native Seeds/SEARCH, Tucson.

Neel, James V. and Richard H. Ward
1970 Village and Tribal Genetic Distances Among American Indians and the Possible Implications for Human Evolution. National Academy of Sciences Proceedings 65:323-330.

Nelson, Lowery
1952 The Mormon Village: A Pattern and Technique of Land Settlement. University of Utah Press, Salt Lake City.

Nelson, Pearl Udall, editor
1959 Arizona Pioneer Mormon: David King Udall, His Story and His Family. Arizona Silhouettes, Tucson.

Nickens, Paul R.
1982 A Summary of the Prehistory of Southeastern Utah. In Contributions to the Prehistory of Southeastern Utah, by Paul R. Nickens, Kevin D. Black, James M. Copeland, and Steven M. Horvath, Jr. USDI Bureau of Land Management, Utah, Cultural Resource Series 13. Salt Lake City.

Nickens, Paul R., and Kenneth L. Kvamme
1981 Archaeological Investigations at the Kanab Site. In Excavation of Two Anasazi Sites in Southern Utah, assembled by Richard K. Fike and David B. Madsen. Utah State Office, Bureau of Land Management.

Niehuis, Charles C.
n.d. Untitled manuscript on file at the Arizona Historical Society, Tucson.

Nusbaum, Jesse L.
1922 A Basket Maker Cave in Kane County, Utah. Indian Notes and Monographs, Miscellaneous Series No. 29. Museum of the American Indian, Heye Foundation, New York.

Olsen, Robert W., Jr.
1965 Pipe Springs, Arizona and Thereabouts. Journal of Arizona History 6:11-20.

1966 Winsor Castle: Mormon Frontier Fort at Pipe Spring. Utah Historical Quarterly 34:218-226.

1969 The Powell Survey Kanab Base Line. Utah Historical Quarterly 37:261-268.

Olson, Kathryne.
1979 An Attribute Analysis of Muddy River Ceramics. Western Anasazi Reports 2:303-364. Cedar City, Utah.

Opler, Marvin K.
1939 Southern Paiute Pottery Types. Masterkey 13:161-163.

Osbourne, Douglas
1941 Archaeological Reconnaissance in Western Utah and Nevada, 1939. Masterkey 14:189-195. Los Angeles.

Owen, Roger C.
1965 The Patrilocal Band: A Linguistically and Culturally Hybrid Social Unit. American Anthropologist 67:675-690.

Palmer, Edward
1876 Exploration of a Mound in Utah. American Naturalist 10:410-414. New York.

1878 Plants Used by the Indians of the United States. American Naturalist 12:593-606, 646-655.

Palmer, William R.
1933 Paiute Indian Homelands. Utah Historical Quarterly 6:88-102.

Pare, Charles P.
1982 California (Coastal) Chaparral. In Biotic Communities of the American Southwest: United States and Mexico, edited by David E. Brown, pp. 91-94. Desert Plants, Vol. 4, No. 1-4. University of Arizona Press, Tucson.

Pare, Charles P., and David E. Brown

1982a Interior Chaparral. In Biotic Communities of the American Southwest: United States and Mexico, edited by David E. Brown, ppl 95-99. Desert Plants, Vol. 4, No. 1-4, University of Arizona Press, Tucson.

1982b Rocky Mountain (Petvan) and Madrean Montane Conifer Forests. In Biotic Communities of the American Southwest: United States and Mexico, edited by David E. Brown pp. 43-48. Desert Plants, Vol. 4, No. 1-4, University of Arizona Press, Tucson.

1982c Rocky Mountain (Petvan) Subalpine Conifer Forest. In Biotic Communities of the American Southwest: United States and Mexico, edited by David E. Brown, pp. 37-39. Desert Plants, Vol. 4, No. 1-4, University of Arizona Press, Tucson.

Parry, Tom

1977 Final Report for an Archaeological Clearance Survey of the proposed Moccasin Springs Pipeline, Kaibab Paiute Indian Reservation, Mohave County, Arizona. MS. on file, Museum of Northern Arizona, Flagstaff.

Peebles, Christopher S., and Susan M. Kus

1977 Some Archaeological Correlates of Ranked Societies. American Antiquity 42:421-448.

Pendergast, David M.

1960 The Frei Site, Santa Clara, Utah. Special Report to the Utah State Parks and Recreation Commission. Reprinted (1962). University of Utah Anthropological Papers, No. 60, pp. 127-163. Salt Lake City.

Pendleton, Mark A.

1939a The Orderville United Order of Zion. Utah Historical Quarterly 7:141-159.

1939b The Orderville United Order of Zion. Utah Historical Quarterly 8:141-200.

Petersen, Kenneth L.

1983 Reconstruction of Droughts and Summer Warmth for the Dolores Archaeological Project Area, Southwest Colorado: A.D. 550 to 950. Paper presented at the 2nd Anasazi Symposium, Farmington, New Mexico.

Peterson, Charles S.

1967 Settlement on the Little Colorado, 1873-1900: A Study of the Process and Institutions of Mormon Expansion. Ph.D. dissertation, University of Utah.

1973 Take up Your Mission: Mormon Colonizing Along the Little Colorado River 1870-1900. University of Arizona Press, Tucson.

Pianka, Eric R.

1974 Evolutionary Ecology, Harper and Row, Publishers, New York.

Pilles, Peter J.

1981 A Review of Yavapai Archaeology. In The Protohistoric Period in the North American Southwest, A.D. 1450-1700, edited by David R. Wilcox and W. Bruce Masse, pp. 163-182. Arizona State University Anthropological Research Papers 24. Tempe.

Pimental, R. A.
1979 Morphometrics: The Multivariate Analysis of Biological Data. Kendall/Hunt, Dubuque.

Plog, Fred T.
1979 Prehistory: Western Anasazi. In Southwest, edited by Alfonso Ortiz, pp. 28-43. Handbook of North American Indians, Vol. 9, William G. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

1981 Cultural Resources Overview: Little Colorado Area. USDA-Forest Service and Arizona Bureau of Land Management, Albuquerque and Phoenix.

1983 Human Adaptation to Arid Environments: the Anasazi Case. Paper presented before the 2nd Anasazi Conference, Farmington, New Mexico.

Plog, Fred T., and James N. Hill
1971 Explaining Variability in the Distribution of Sites. In The Distribution of Prehistoric Population Aggregates, edited by George J. Gumerman, pp. 7-36. Prescott College Anthropological Reports No. 1, Prescott.

Plog, Stephen, editor
1986 Spatial Organization and Exchange: Archaeological Survey on Northern Black Mesa. Southern Illinois University Press, Carbondale.

Pomeroy, Earl
1957 In Search of the Golden West: The Tourist in Western America. Alfred A. Knopf, New York.

Powell, John W.
1961 The Exploration of the Colorado River and Its Canyons. Dover Publications, Inc., New York.

Powell, John W., and G. W. Ingalls
1874 Report on the Conditions of the Ute Indians of Utah; the Paiutes of Utah, Northern Arizona, Southern Nevada and Southeastern California; the Go Si Utes of Utah and Nevada; the Northwestern Shoshones of Idaho and Utah; and the Western Shoshones of Nevada, and Report Concerning Claims of Settlers in the Moapa Valley (Southeastern Nevada). House Executive Document 157, 43rd Congress, 1st Session. Government Printing Office, Washington.

Powell, Shirley
1983 Mobility and Adaptation: The Anasazi of Black Mesa, Arizona. Southern Illinois University Press, Carbondale.

Powell, Shirley and Anthony L. Klesert
1980 A Method for Predicting the Presence of Buried Structures on Unexcavated Artifact Scatters. In Papers on the Archaeology of Black Mesa, Arizona, Vol. II, edited by Stephen Plog and Shirley Powell, pp. 39-46. Southern Illinois University Press, Carbondale.

Prevy, Jack
1967 Letter to P. T. Reilly. Copy on file, Fredonia Public School Manuscript Collection No. 161, Northern Arizona University Special Collections Library, Flagstaff.

Price, Virginia N., and John T. Darby
1964 Preston Nutter: Utah Cattleman. Utah Historical Quarterly 32:232-251.

Price, Barbara J.
1982 Cultural Materialism: A Theoretical Review. American Antiquity 47:709-741.

Price, T. Douglas and James A. Brown, editors
1985 Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity. Academic Press, New York.

Pyne, Stephen J.
1982 Dulton's Point: An Intellectual History of the Grand Canyon Grand Canyon Natural History Association Monograph No. 5, Grand Canyon, Arizona.

Rafferty, Kevin and Lynda Blair
1984 Billy Goat Peak: An Investigation and Reinterpretation of Virgin Anasazi and Paiute Prehistory and Ethnohistory. Report submitted to the Nevada Division of Historic Preservation and Archaeology. Division of Anthropological Studies, Environmental Research Center, University of Nevada, Las Vega.

Raitz, Karl B.
1973 Theology on the Landscape: A Comparison of Mormon and Amish-Mennonite Land Use. Utah Historical Quarterly 41:23-34.

Rambeau, Norman and Winona Holmes
1976 Nuwuvi: A Southern Paiute History. University of Utah Printing Service of the Intertribal Council of Nevada, Salt Lake City.

Rasmussen, D. Irvin
1941 Biotic Communities of Kaibab Plateau, Arizona. Ecological Monographs 11:229-275.

Rasor, Charles A.
1949 Report on Investigation of Radioactive Minerals at Hack's Canyon Mine, Mohave County, Arizona. U.S. Atomic Energy Commission Preliminary Report. Copy on file, A.E.C. Field Office, Albuquerque, New Mexico.

Reed, Erik K.
1946 The Distinctive Features of the San Juan Anasazi Culture. Southwestern Journal of Anthropology 2:295-305.

Reid, H. Lorenzo
1964 Brigham Young's Dixie of the Desert: Exploration and Settlement. Zion National Park Association, Zion National Park.

Reilly, P. T.
1960 The Juno Ruin. Masterkey, 40:16-22. Los Angeles.

1971 Warren Marshall Johnson: Forgotten Saint. Utah Historical Quarterly 39:3-22.

1974 Kanab United Order: The President's Nephew and the Bishop. Utah Historical Quarterly 42:144-164.

1977 Historic Utilization of Paria River. Utah Historical Quarterly 45.

Reilly, P. T.
1978 Roads Across Buckskin Mountain. The Journal of Arizona History 19:379-402.

Reinhard, Karl J.
1984 Dietary and Parasitological Study of Feces from Turkey Pen Alcove. Unpublished report submitted to Peggy Powers, Division of Contract Archaeology, San Juan County Archaeological Museum and Library at Salmon Ruins, Farmington.

Reinhard, Karl J., J. Richard Ambler, and Magdalene McGuffie
1985 Internal Parasites and Diet at Dust Devil Cave. American Antiquity 50:819-824.

Reinhard, Karl J. and Nicholas J. Czaplewski
1984 Faunal and Fungal Remains from Dust Devel Cave Feces. Paper presented at the 19th Biennial Great Basin Anthropological Conference, Boise, Idaho.

Reinhard, Karl J., and John G. Jones
1987 Dietary and Parasitological Analysis of Turkey Pen Cave: A Basketmaker II Village in the Grand Gulch, Utah. In Proceedings of the Southwestern Conference on Paleopathology. In press.

Renfrew, Colin
1977 Alternative Models for Exchange and Spatial Distribution. In Exchange Systems in Prehistory, edited by Timothy K. Earle and Jonathon E. Ericson, pp. 71-90. Academic Press, New York.

Rhoads, John G. and Jonathan S. Friedlaender
1975 Language Boundaries and Biological Differentiation on Bougainville: Multivariate Analysis of Variance. National Academy of Science Proceedings 65:323-330.

Rice, Glenn, Rick Effland, and Laurie Blank-Roper
1980 A Sample Survey of Tusayan Planning Unit 1, Kaibab National Forest, Arizona. USDA-Forest Service, Southwestern Region Cultural Resources Report No. 33.

Ricks, Joel Edward
1964 Forms and Method of Early Mormon Settlement in Utah and the Surrounding Region, 1847-1877. Utah State University Monograph Series 11.

Rider, Rowland W., and Deirore Paulsen
1979 Sixshooters and Sagebrush: Cowboy Stories of the Southwest. Brigham Young University Press, Provo, Utah.

Riffy, John
1970 Information Concerning the History of the Grand Canyon National Monument. Ms. on file, Museum of Northern Arizona, Flagstaff.

Riggs, Brigham A.
1938 Life Story of Quag-unt, As Told to Brigham A. Riggs, A Cattleman of Kanab. Ms. on file, Bancroft Library, Berkeley.

Roberts, Allen D.
1975 Religious Architecture of the LDS Church: Influences and Changes since 1847. Utah Historical Quarterly 43:301-327.

Robinson, Adonis Findley
1970 History of Kane County. Utah Printing Co., Salt Lake City.

Robinson, William J.
1976 Tree Ring Dating and Archaeology in the American Southwest, Tree-Ring Bulletin, 36:9-20.

Rogers, Malcolm J.
1929 Report of an Archaeological Reconnaissance in the Mohave Sink. San Diego Museum Papers 1. San Diego.

1939 Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas. San Diego Museum of Man Papers No. 3. San Diego.

1945 An Outline of Yuman Prehistory. Southwestern Journal of Anthropology 1:167-198.

Roney, John
1977 Livestock and Lithics: The Effects of Trampling. Ms. on file, Bureau of Land Management, Albuquerque District, Albuquerque.

Rose, Martin R., Jeffrey S. Dean, and William J. Robinson
1981 The Past Climate of Arroyo Hondo New Mexico Reconstructed from Tree Rings. Arroyo Hondo Archaeological Series, Vol. 5., School of American Research Press, Santa Fe.

Rouse, Irving
1986 Migrations in Prehistory: Inferring Population Movement from Cultural Remains. Yale University Press, New Haven.

Rudy, Jack R.
1953 Archaeological Survey of Western Utah. University of Utah Anthropological Papers No. 12. Salt Lake City.

1954 Pine Park Shelter, Washington County, Utah. University of Utah Anthropological Papers No. 18. Salt Lake City.

Rudy, Jack R., and Robert D. Stirland
1950 An Archaeological Reconnaissance in Washington County, Utah. University of Utah Anthropological Papers No. 9.

Ruppert, David E.
1976 Lake Mead National Recreation Area: An Ethnographic Overview. Western Archaeological Center, National Park Service, Tucson.

Rusho, W.J., and C. Gregory Crampton
1981 Desert River Crossing: Historic Lee's Ferry on the Colorado River. Peregrine Smith Inc., Salt Lake City. 2nd revised edition.

Russo, John P.
1964 The Kaibab North Deer Herd: Its History, Problems, and Management. Arizona Game and Fish, Phoenix.

Sahlins, Marshall
1972 Stone Age Economics. Aldine Publishing Company, Chicago.

Sandage, Della W.
1974 Sketch of Allen Frost. In Pioneer Men of Arizona. Edited by Roberta F. Clayton, pp. 190-192. Privately printed by Roberta F. Clayton.

Sapir, Edward.
1910a Kaibab Southern Paiute Field Notes. Ms. No. 30 (U.3), Freeman No. 2643, American Philosophical Society Library, Philadelphia.

1910b Song Recitative in Paiute Mythology. Journal of American Folklore 23(90):455-472.

1930 The Southern Paiute Language. Proceedings of the American Academy of Arts and Sciences 65(1-3). Boston.

1931 Southern Paiute Dictionary. Papers of the American Academy of the Arts and Sciences 65(3).

Sayles, E. B., and Ernst Antevs
1941 The Cochise Culture. Medallion Papers No. 29, Globe, Arizona.

Schaafsma, Polly
1971 The Rock Art of Utah: From the Donald Scott Collection. Peabody Museum of American Archaeology and Ethnology Papers No. 22.

1980 Indian Rock Art of the Southwest. University of New Mexico Press, Albuquerque.

1988 Shaman's Gallery: A Tuckup Canyon Rock Art Site. Report prepared for Grand Canyon National Park, Grand Canyon, Arizona.

Schaefer, Paul D.
1969 Prehistoric Trade in the Southwest and the Distribution of Pueblo IV Hopi Jeddito Black-on-yellow. Kroeber Anthropological Papers 41:54-77.

Scharff, Robert
1967 Grand Canyon National Park. David McKay, New York.

Schenk, Edward T.
1937 A Preliminary Investigation of the Archaeology and Geology of Lower Grand Canyon. Ms. on file, Boulder Dam National Recreation Area and Western Archaeological and Conservation Center, Tucson.

Schiffer, Michael B. and Susan J. Wells
1982 Archaeological Surveys: Past and Future. In Hohokam and Patayan: Prehistory of Southwestern Arizona, edited by Randall H. McGuire and Michael B. Schiffer, pp. 345-383. Academic Press, New York.

Schiowitz, Robert
1984 Brink (Powell) Monument: A Cultural Resources Survey Report. Ms. on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Schoenwetter, James
1962 Pollen Analysis of Eighteen Archaeological Sites in Arizona and New Mexico. In Chapters in the Prehistory of Eastern Arizona, by Paul S. Martin et al., Fieldiana: Anthropology 53:168-209. Chicago Museum of Natural History.

1970 Archaeological Pollen Studies of the Colorado Plateau. American Antiquity 35.

1976 A Test of the Colorado Plateau Pollen Chronology. Journal of the Arizona Academy of Science 11:89-96.

Schoenwetter, James, and Alfred E. Dittert, Jr.
1968 An Ecological Interpretation of Anasazi Settlement Patterns. In Anthropological Archaeology in the Americas, edited by Betty J. Meggers, pp. 41-66. Anthropological Society of Washington.

Schoenwetter, James, and Frank W. Eddy
1964 Alluvial and Palynological Reconstruction, Navajo Reservoir District. Museum of New Mexico Papers in Anthropology No. 13, Albuquerque.

Schroedl, Alan R.
1976 The Archaic of the Northern Colorado Plateau. Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City. University Microfilms, Ann Arbor.

1977 The Grand Canyon Figurine Complex. American Antiquity 42:254-265.

Schroedl, Alan R., Allison Bingham, Gary M. Brown, Linda Scott Cummings, and C. Dean Wilson
n.d. Cultural Resource Inventory of the Kaibab Plateau, Grand Canyon, Arizona: Highway 67 Data Recovery Project. Draft Report submitted to the USDI National Park Service, Western Region, Interagency Archaeological Services, San Francisco.

Schroeder, Albert H.
1952 The Significance of Willow Beach. Plateau 25:27-29. Flagstaff.

1953 A Few Sites in the Moapa Valley, Nevada. Masterkey 27:18-24, 62-68.

1955 The Archeology of Zion Park. University of Utah Anthropological Papers No. 22, Salt Lake City.

1961 The Archeological Excavations at Willow Beach, Arizona, 1950. University of Utah Anthropological Papers No. 50. Salt Lake City.

1963 Comment on Gunnerson's Plateau Shoshonean Prehistory. American Antiquity 28:559-560. Salt Lake City.

Schroeder, Mark J., and Charles Buck
1970 Fire Weather: A Guide for Application of Meteorological Information to Forest Fire Control Operations. USDA Forest Service Agriculture Handbook 360. Washington D.C.

Schwartz, Douglas W.
1957 Climate Change and Culture History in the Grand Canyon Region. American Antiquity 22:372-377.

Schwartz, Douglas W.
1960 Archaeological Investigations in the Shinumu Area of Grand Canyon, Arizona. Plateau 32:61-67. Flagstaff.

1963 An Archeological Survey of Nankoweap Canyon, Grand Canyon National Park. American Antiquity 28:289-302. Salt Lake City.

1965 Nankoweap to Unkar: An Archaeological Survey of the Upper Grand Canyon. American Antiquity 30:278-296. Salt Lake City.

1966 A Historical Analysis and Synthesis of Grand Canyon Archaeology. American Antiquity 31:469-484. Salt Lake City.

1970 The Postmigration Culture: A Base for Archaeological Inference. In Reconstructing Prehistoric Pueblo Societies, edited by William A. Longacre, pp. 175-193. University of New Mexico Press, Albuquerque.

Schwartz, Douglas W., Authur L. Lange, and Raymond de Saussure
1958 Split Twig Figurines in the Grand Canyon. American Antiquity 23:264-274.

Schwartz, Douglas W., Michael P. Marshall, and Jane Kepp
1979 Archaeology of the Grand Canyon: The Bright Angel Site. Grand Canyon Archaeology Series, School of American Research, Santa Fe.

Schwartz, Douglas W., Richard C. Chapman, and Jane Kepp
1980 Unkar Delta. Grand Canyon Archaeology Series. School of American Research, Santa Fe.

Schwartz, Douglas W., Jane Kepp, and Richard C. Chapman
1981 The Walhalla Plateau. Grand Canyon Archaeology Series. School of American Research, Santa Fe.

Scott, Linda J.
1979 Pollen analysis in selected rooms at Walpi and along modern transects near First Mesa. Paper presented at Second Annual Conference of Ethnobiology, Flagstaff.

1981 Pollen Analysis of 42Ka1969. In Archaeological Investigations at the Kanab Site, Kane County, Utah. Edited by Paul R. Nickens, and Kenneth L. Kvamme. Utah Bureau of Land Management Cultural Resources Series No. 9, Salt Lake City.

1985 Pollen and Macrofossil Interpretations. In Archaeological Test Excavations at the Energy Fuels Nuclear, Inc. Vermillion Cliffs Project, Kane County, Utah. Edited by Deborah A. Westfall. Abajo Archaeology, Bluff, Utah.

1987 The Pinenut Site Pollen Analysis. In The Pinenut Site: Virgin Anasazi Archaeology on the Kanab Plateau of Northwestern Arizona, by Deborah A. Westfall, pp. 161-172. USDI Bureau of Land Management, Arizona, Cultural Resource Series 4. Phoenix.

Scott, Linda, and Mark A. Stiger
1981 Pollen Analysis of Cultural Features and Coprolites from Glen Canyon National Recreation Area. Appendix IV. In Archaeological Research in Glen Canyon, 1977, by Alan R. Schroedl. Ms. on file, United States Department of the Interior, National Park Service, Midwest Archaeological Center, Lincoln.

Seegmiller, Emma C.
1939 Personal Memories of the United Order of Orderville, Utah. Utah Historical Quarterly 7:160-200.

Sellers, W. D., and Richard H. Hill, editors
1974 Arizona Climate, 1931-1972. University of Arizona Press, Tucson.

Sellers, W. D., Richard H. Hill, and Margaret Sanderson-Rae
1985 Arizona Climate, The First Hundred Years. University of Arizona Press, Tucson.

Service, Elman R.
1962 Primitive Social Organization: An Evolutionary Perspective. Random House, New York.

Shankland, Robert
1951 Steve Mather of the National Parks. Alfred A. Knopf, New York.

Sharrock, Floyd, W., Keith M. Anderson, Don D. Fowler, and David S. Dibble
1963 1961 Excavations, Glen Canyon Area. University of Utah Anthropological Papers 63. Salt Lake City.

Shiras, G. III
1924 The Mule Deer of the Kaibab National Game Preserve. Unpublished memorandum on file, Kaibab National Forest Supervisors Office, Williams, Arizona.

Shutler, Richard
1961 Lost City, Pueblo Grande de Nevada. Nevada State Museum Anthropological Papers No. 5. Carson City.

1967a Cultural Chronology in Southern Nevada. In Pleistocene Studies in Southern Nevada, Part 6, edited by H. M. Wormington and D. Ellis, pp. 305- 308. Nevada State Museum Anthropological Papers No. 13. Carson City.

1967b Archaeology of Tule Springs. Nevada State Museum Papers No. 13:299-303.

Shutler, Richard, and Mary Shutler
1962 Archeological Survey in Southern Nevada. Nevada State Museum Anthropological Papers No. 7. Carson City.

Shutler, Richard, Mary E. Shutler, and James S. Griffith
1960 Stuart Rockshelter: A Stratified Site in Southern Nevada. Nevada State Museum Anthropological Papers 3. Reno.

Simpson, J.H.
1876 Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon Route from Camp Floyd to Genoa, in Carson Valley, in 1859. U. S. Government Printing Office, Washington, D.C.

Smiley, F.E., William J. Parry, and George J. Gumerman
1986 Early Agriculture in the Black Mesa/Marsh Pass Region of Arizona: New Chronometric Data and Recent Excavations at Three Fir Shelter. Paper presented at the 51st Annual Meeting of the Society for American Archaeology, April 26, New Orleans.

Smith, Elmer R.
1940 A Brief Description of an Indian Ruin Near Shunesberg, Utah. University of Utah Anthropological Papers No. 4. Salt Lake City. (Reprinted from Zion and Bryce Nature Notes 6(1), 1934).

Smith, Melvin
1972 The Colorado River: Its History in the Lower Canyon Area. Unpublished Ph.D. dissertation, Department of History, University of Utah, Salt Lake City.

Smith, Watson
1952 Excavations in Big Hawk Valley, Wupatki National Monument. Museum of Northern Arizona Bulletin 24, Flagstaff.

Soper, A. W.
1930 Report on Archaeological Findings in Bright Angel Canyon. Ms. on file, Western Archaeological and Conservation Center, Tucson.

Soule, Edwin C.
1975 Lost City Revisited. The Masterkey 49:4-19.

1976 Lost City II: The Masterkey 50:10-18.

Spaulding, W. Geoffrey
1983 Late Wisconsin Macrofossil Records of Desert Vegetation in the American Southwest. Quaternary Research 19:256-264.

1985 Vegetation and Climate of the Past 45,000 Years in the Vicinity of the Nevada Test Site, South-central Nevada. U.S. Geological Survey Professional Paper 1329:1-55.

Spicer, Edward H.
1971 Persistent Cultural Systems. Science 174:795-800.

Spier, Leslie
1928 Havasupai Ethnography. Anthropological Papers of the American Museum of Natural History 33(2).

Spencer, Joseph E.
1934 Pueblo Sites of Southwestern Utah. American Anthropologist 36:70-80.

1936 The Middle Virgin Valley, Utah: A Study in Culture Growth and Change. Ph.D. dissertation, Department of Anthropology, University of California, Berkeley.

Staley, Gregory
1969 Excavations at the Wild Goose site (NA 9059) on the Virgin River near St. George, Utah. Preliminary report dated August 4, 1969, on file, Museum of Northern Arizona, Flagstaff.

Stallings, W. S.
1941 A Basketmaker II Date from DuPont Cave, Utah. Tree Ring Bulletin 8(1):3-6. Tucson.

Steere, Peter L.
1987 National Forest Fire Lookouts in the Southwestern Region, USDA-Forest Service. Ms. on file, USFS Southwest Regional Office, Albuquerque and USFS Kaibab National Forest Supervisors Office, Williams, Arizona.

Steere, Peter L. and Keith L. Miller
n.d. Evaluation Report for Fire Lookout Towers in the Southwest Region of the U.S. Forest Service. Ms. on file, USDA-Forest Service, Southwest Region Office, Albuquerque.

Stegner, Wallace
1942 Mormon Country. Duell, Sloan, and Pearce, New York.

1954 Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West. The Riverside Press, Cambridge. (Originally published in 1953 by Houghton Mifflin Company, Boston)

1982 Beyond the Hundredth Meridan: John Wesley Powell and the Second Opening of the West. Houghton Mifflin, Cambridge, Massachusetts.

Steward, Julian H.
1933 Archaeological Problems of the Northern Periphery of the Southwest. Museum of Northern Arizona Bulletin No. 5. Flagstaff.

1936 The Economic and Social Basis of Primitive Bands. In Essays in Anthropology Presented to Alfred L. Kroeber, edited by Robert H. Lowie, pp. 3-79. University of California Press, Berkeley.

1938 Basin-Plateau Aboriginal Sociopolitical Groups. Bureau of American Ethnology Bulletin No. 120. Washington, D.C.

1939 Notes on Hiller's Photographs of the Paiute and Ute Indians taken on the Powell Expedition of 1873. Smithsonian Institution Miscellaneous Collections 98(18). Washington, D.C.

1941 Archaeological Reconnaissance of Southern Utah. Bureau of American Ethnology, Bulletin Vol. 128, No. 18. Washington, D.C.

1955 Theory of Culture Change. University of Illinois Press, Urbana.

1965 Some Problems Raised by Roger C. Owen's "The Patrilocal Band...." American Anthropologist 67:732-734.

1970 The Foundations of Basin-Plateau Shoshonean Society. In Languages and Cultures of Western North America: Essays in Honor of Swen S. Liljeblad., edited by Earl H. Swanson, pp. 113-151. Caldwell, Idaho.

Stewart, Omer C.
1942 Culture Element Distributions: XVIII: Ute Southern Paiute. University of California Anthropological Papers 6(4).

1966 Tribal Distributions and Boundaries in the Great Basin. In The Current Status of Anthropological Research in the Great Basin: 1964, pp. 167-238. Desert Research Institute, University of Nevada, Reno.

Stewart, Omer C.
1982 Indians of the Great Basin: A Critical Bibliography. Indiana University Press, Bloomington.

Stiger, Mark A.
1981 Dietary Analysis of Human Coprolites from Rappel Ruin (42SA683), Glen Canyon Recreation Area. Appendix III in Archaeological Research in Glen Canyon, 1977, by Alan R. Schroedl, pp. 360-367. Ms. on file, USDI National Park Service, Midwest Archaeological Center, Lincoln.

Stockton, Charles W.
1971 The Feasibility of Augmenting Hydrologic Records Using Tree Ring Data. Ph.D. dissertation, University of Arizona, Tucson, University Microfilms, Ann Arbor.

1975 Long-term Streamflow Records Reconstructed from Tree Rings. Papers of the Laboratory of Tree-Ring Research No. 5. University of Arizona Press, Tucson.

1976 Long-term Streamflow Reconstruction in the Upper Colorado River Basin Using Tree Rings. In Colorado River Basin Modeling Studies, Proceedings of a Seminar held at Utah State University, edited by Calvin G. Clyde, Donna H. Flakenborg, and J. Paul Riley, pp. 401-441. Utah Water Research Lab, College of Engineering, Utah State University, Logan.

1979 Potential of Long-Term Forecasting Methods, In Report on Conference on Western Water Issues, edited by Morton S. Isaacson and Theresa C. Fall, pp. 17-21. California Institute of Technology EQL Memorandum No. 22.

Stockton, Charles W., and Harold C. Fritts
1971 Augmenting Annual Runoff Records Using Tree-Ring Data. In Hydrology and Water Resources in Arizona and the Southwest, Vol. 1, pp. 1-12. Proceedings of the 1971 Meetings of the Arizona Section-American Water Resources Association and the Hydrology Section, Arizona Academy of Science, Tempe.

1973 Long-term Reconstruction of Water Level Changes for Lake Athabaska by Analysis of Tree-Rings. Water Resources Bulletin 9:1006-1027.

Stockton, Charles W., and William R. Boggess
1980 Augmentation of Hydrologic Records Using Tree Rings. In Proceedings of the Engineering Foundation Conference on Improved Hydrologic Forecasting - Why and How, pp. 239-265. American Society of Civil Engineers, Pacific Grove, California.

Stockton, Charles W., and David M. Meko
1975 A Long-Term History of Drought Occurrence in the Western United States as Inferred From Tree Rings. Weatherwise 28:244-249.

Stockton, Charles W. and Gordon C. Jacoby
1976 Long-term surface Swater Supply and Streamflow Levels in the Upper Colorado River Basin. Lake Powell Research Project Bulletin No. 18. Institute of Geophysics and Planetary Physics, University of California at Los Angeles.

Stoffle, Richard W., and Henry F. Dobyns
1983 Nuvagantu: Nevada Indians Comment on the Intermontaine Power Project. Nevada Bureau of Land Management Cultural Resources Series No. 7, Reno.

Stoffle, Richard W., and M.J. Evans

1976 Resource Competition and Population:A Kaibab Paiute Ethnohistorical Case. Ethnohistory 23(2):173-197.

1978 Kaibab Paiute History: The Early Years. Kaibab Paiute Tribe, Fredonia. (Reprinted from Ethnohistory 23(2), 1976.)

Stokes, Marvin

1965 The Differentiation of Tracheary Elements from the Cambian of *Pinus edulis* Engelm: The Correlation of Differentiation with Measured Ring Width and Environmental Factors. M.S. thesis, University of Arizona, Tucson.

Stokes, Marvin A., and Terah L. Smiley

1968 An Introduction to Tree-Ring Dating, University of Chicago Press, Chicago.

Stone, Connie L.

1986 Deceptive Desolation: Prehistory of the Sonoran Desert in West Central Arizona. Bureau of Land Management, Arizona, Cultural Resource Series 1. Phoenix.

1987 People of the Desert, Canyons and Pines: Prehistory of the Patayan Country in West Central Arizona. Bureau of Land Management, Arizona. Cultural Resource Series No. 5. Phoenix.

Stroup, Ann

1972 Faunal Analysis at Dust Devil Cave, Utah. Ms. on file, Department of Anthropology, Northern Arizona University, Flagstaff.

Sturdevant, G. E.

1928 A Reconnaissance of the Northeastern Part of Grand Canyon National Park. Grand Canyon Nature Notes 3(5):1-16. Grand Canyon.

Sullivan, Maurice S.

1934 The Travels of Jedediah Smith: A Documentary Outline Including the Journal of the Great American Pathfinder. The Fine Arts Press, Santa Ana, California.

1936 Jedediah Smith: Trader and Trail Breaker. Press of the Pioneers, New York.

Sutton, Mark Q.

1984 Short-term and Long-term Optimal Foraging Strategies: A Model of Numic Expansion in the Great Basin. Paper presented at the 19th Biennial Great Basin Anthropological Conference, Boise, Idaho.

1987 A Consideration of the Numic Spread. Unpublished Ph.D. Dissertation, Department of Anthropology, University of California, Riverside.

Swapp, Ben

1966 Untitled Ms. Prepared for Forest Service Old Timers Club, Odgen, Utah. Copy on file, Fredonia Public School Manuscript Collection No. 161, Northern Arizona University Special Collections Library, Flagstaff.

Swarthout, Jeanne

1981 Final Report for an Archaeological Overview for the Lower Colorado River Valley, Arizona, California, and Nevada, Reach 4: Lower Virgin River. Prepared for Bureau of Reclamation. Copy on file, Museum of Northern Arizona Library, Flagstaff.

Sweeny, Catherine, and Robert C. Euler

1963 Southern Paiute Archaeology in the Glen Canyon Drainage. Nevada State Museum Anthropological Papers No. 9. Carson City.

Tainter, Joseph A., editor

1984 Predictive Modeling and the Mckinley Mine Dilemma. American Archaeology. Vol. 4, No.'s 1 & 2.

Tavernetti, Leonard Ray

1971 The Spatial Organization and Economic Focus of the Arizona Strip. M. A. thesis, University of Arizona, Tucson.

Taylor, Walter W.

1958 Two Archaeological Studies in Northern Arizona. The Pueblo Ecology Study: Hail and Farewell and a Brief Survey through the Grand Canyon of the Colorado River. Museum of Northern Arizona Bulletin No. 30. Flagstaff.

Teague, George, and Carole McClellan

1978 Archeological Reconnaissance of Lands Adjacent to the Grand Canyon. National Park Service, Western Archeological Center. Tucson.

Thomas, David H.

1973 An Empirical Test for Steward's Model of Great Basin Settlement Patterns. American Antiquity 38:155-176.

1981 How to Classify the Projectile Points from Monitor Valley, Nevada. Journal of California and Great Basin Anthropology 3(1):7-43.

Thomas, Prentice M., Jr., Janice L. Cambell, Mark T. Swanson, Jeffery H. Altschul, and Carol S. Weed

1983 An Intensive Study of a 2200 Area Tract Within a Proposed Manuever Area at the Fort Benning Military Reservation, Chattahoochee County, Georgia. New World Research, Inc. Report of Investigations No. 71. In Fulfillment of Contract CX5000-2-0087, National Park Service, Southeast Region, Archaeological Services Branch.

Thompson, Richard A.

1970 Prehistoric Settlement in the Grand Canyon National Monument. Southern Utah State College Faculty Research Series No. 1. Cedar City, Utah.

1971a The Grand Canyon National Monument: 1970 Archeological Survey Preliminary Report. Ms. Southern Utah State College. Cedar City.

1971b Prehistoric Settlement in the Grand Canyon National Monument. Plateau 44:67-71. Flagstaff.

1978a Archaeological Report on the Pipe Springs National Monument Utilities Project. Western Anasazi Reports 1:61-65. Cedar City.

1978b Comment Solicited. Western Anasazi Reports 1:68-70. Cedar City.

Thompson, Richard A.
1978c The Western Anasazi Workshop, 1977. Western Anasazi Reports 1:3-12. Cedar City.

1979 A Projection of Archeological Site Densities in the Slide Mountain, Tuckup Point, and Jensen Tank Areas of the Grand Canyon National Park. Western Anasazi Reports 2:234-255. Cedar City.

Thompson, Richard A., and Daphne C. Dalley, editors
1978 The Western Anasazi Workshop, 1978. Western Anasazi Reports 1:305-393. Cedar City, Utah.

Thompson, Richard A., and Georgia Beth Thompson
1974 A Preliminary Report of Excavations in the Grand Canyon National Monument. Sites: GC 670, GC 761, and GC 663. Ms. on file, Grand Canyon National Park, Grand Canyon and Southern Utah State College, Cedar City.

1978 The Little Jug Site: 1976-1977. Ms. on file, Grand Canyon National Park, Grand Canyon and Southern Utah State College, Cedar City.

Thompson, Richard A., Georgia Beth Thompson, and Jessie Embry
1983 Class I Cultural Resource Inventory for the Cedar City District of the Bureau of Land Management, Part I, Cultural Resource Overview. Ms. on file, Bureau of Land Management, Cedar City District, Cedar City.

Thompson, R. S., and E. M. Hattori
1983 Packrat (Neotoma) Middens from Gatecliff Shelter and Holocene Migration of Woodland Plants. In The Archaeology of Monitor Valley 2, Gatecliff Shelter, edited by David H. Thomas, pp. 157-167. American Museum of Natural History Anthropology Paper 59.

Thornthwaite, C. W., C. F. S. Sharpe, and E. F. Dosch
1942 Climate and Accelerated Erosion in the Arid and Semiarid Southwest with Special Reference to the Polacca Wash Drainage Basin, Arizona. U.S. Department of Agriculture Technical Bulletin 808.

Tillotson, Minor, Raymond and Frank J. Taylor
1929 Grand Canyon Country. Stanford University Press, Palo Alto.

Tipps, Betsy L.
1983 The Captains Alcove: Test Excavations in Glen Canyon National Recreation Area, Kane County, Utah. Unpublished M.A. thesis, Department of Anthropology, Washington State University, Pullman.

1983 The Tar Sands Project: Cultural Resource Inventory and Predictive Modelling in Central and Southern Utah. Report submitted to the USDI Bureau of Land Management, Richfield District, Richfield, Utah.

Tuan, Yi-Fu
1966 New Mexican gullies, a critical review and some recent observations. Annals of the Association of American Geographers 56:573-597.

Tuan, Yi-Fu, Cyril E. Everand, Jerald G. Widdison, and Wen Bennett
1973 The Climate of New Mexico, Revised Edition. New Mexico State Planning Office, Santa Fe.

Tucker, Edwin A. and George Fitzpatrick
1972 Men Who Matched the Mountains: The Forest Service in the Southwest. U.S. Government Printing Office, Washington, D.C.

Tuohy, Donald R.
1969 Breakage, Burin Facets, and the Probable Technological Linkage among Lake Mohave, Silver Lake, and Other Varieties of Paleoindian Projectile Points in the Desert West. Nevada State Museum Anthropological Paper No. 14, Miscellaneous Paper on Nevada Archaeology No. 6. Carson City.

1974 A Comparative Study of Late Paleo-Indian Manifestations in the Western Great Basin. Nevada Archaeological Survey Research Paper No. 5. pp. 91-116. Reno.

1980 Obsidian Hydration Dates for Western Great Basin Prehistory. In Anthropological Papers in Memory of Earl H. Swanson, Jr., edited by Lucille B. Harten, Claude N. Warren, and Donald R. Tuohy. Special Publication of the Idaho Museum of Natural History, Pocatello.

Turner, Christy G., II
1963 Petrographs of the Glen Canyon Region: The Styles, Chronology, Distribution, and the Relationships from Basketmaker to Navajo. Museum of Northern Arizona Bulletin No. 38. Flagstaff.

Turner, Raymond M.
1982a Great Basin Desertscrub. In Biotic Communities of the American Southwest: United States and Mexico, edited by David E. Brown, pp. 145-155. Desert Plants, Vol.4, No.1-4. University of Arizona Press, Tucson.

1982b Mohave Desertscrub. In Biotic Communities of the American Southwest: United States and Mexico, edited by David E. Brown, pp. 157-168. Desert Plants, Vol. 4, No.1-4. University of Arizona Press, Tucson.

U. S. Public Health Service
1962 Drinking Water Quality Standards. U.S. Government Printing Office, Washington, D.C.

Van Der Merwe, N. J.
1982 Carbon Isotopes: Photosynthesis and Archaeology. American Scientist 70:596-606.

Van Devender, Thomas R. and James I. Mead
1976 Late Pleistocene and Modern Plant Communities of Shinumo Creek and Peach Springs Wash, Lower Grand Canyon, Arizona. Journal Arizona Nevada Academy Science 11:16-22.

Van Ness, Margaret A.
1984 Macrobotanical Remains from the Human Feces, Dist Devil Cave. Paper presented at the 19th Biennial Great Basin Anthropological Conference, Boise, Idaho.

Van Ness, Margaret A.
1987 Flotation Analysis of the Pinenut Site. In The Pinenut Site: Virgin Anasazi Archaeology on the Kanab Plateau of Northwestern Arizona, edited by Deborah A. Westfall, pp. 173-180. USDI Bureau of Land Management, Arizona, Cultural Resource Series 4. Phoenix.

Vivian, R. Gwinn
1974 Conservation and Diversion: Water Control Systems in the Anasazi Southwest. In Irrigation's Impact on Society, edited by Theodore E. Downing and McGuire Gibson, pp. 95-112. Anthropolgical Papers of the University of Arizona No. 25. Tucson.

Voth, Hazel Hunt, and Harold Gill
1939 Grand Canyon National Park: A Bibliography. Western Museum Laboratory of the National Park Service.

Wade, William D.
1967 Archaeological Investigations in Northwestern Arizona. Ms. Museum of Northern Arizona. Flagstaff.

Wagner, Henry R., and Charles Camp
1921 The Plains and the Rockies. San Francisco.

Wahlquist, Wayne L.
1977 A Review of Mormon Settlement Literature. Utah Historical Quarterly 45:4-21.

Walker, James B.
1974 An Overview of Grand Canyon Prehistory: Final Report. Submitted to the National Park Service in Fulfillment of Contract No CX800030032. On file, Museum of Northern Arizona, Arizona.

Wallace, Edward S.
1955 The Great Reconnaissance: Soldiers, Artists, and Scientists on the Frontier, 1848-1861. Little, Brown and Co., Boston.

Wallace, Robert
1972 The Grand Canyon. American Wilderness/Series; Time Life Books, New York.

Wallace, Theodore
1949 A Brief History of Early Coconino County. M.A. thesis, Northern Arizona University, Flagstaff.

Walling, Barbara A., Richard A. Thompson, Gardiner F. Dalley, and Dennis G. Weder, Kathleen M. Heath, and La Mar W. Lindsay
1986 Excavations at Quail Creek. Bureau of Land Management, Utah, Cultural Resources Series No. 20. Salt Lake City.

Ward, Albert E., editor
1978 Limited Activity and Occupation Sites: A Collection of Conference Papers. Contributions to Anthropological Studies 1. Center for Anthropological Studies, Albuquerque.

Warner, Ted J., editor, and Fray Angelico Chavez, Translator

1976 The Dominguez-Escalante Journal: the Expedition Through Colorado, Utah, Arizona and New Mexico, 1776. Brigham Young University Press, Provo.

Warren, Claude N.

1967 The San Dieguito Complex: A Review and Hypothesis. American Antiquity 32:168-185.

1980 The Archaeology and Archaeological Resources of the Amargosa Mohave Basin Planning Units. In A Cultural Resources Overview of the Amargosa Mohave Basin Planning Units, by Claude N. Warren, Martha Knack, and Elizabeth von Till Warren, pp. 1-134. Cultural Resources Publications in Anthropology and History, Bureau of Land Management, California.

1982 The Desert Region. In California Archaeology, by Michael J. Moratto. Academic Press, New York.

Waters, Bill

1983 The Land Apart. Arizona Highways 59(8):13-29.

Watkins, Frances E.

1945 Moapa Paiute Winter Wickiup. Masterkey 19:13-18. Los Angeles.

Webb, Robert Howard

1985 Late Holocene Flooding on the Escalante River, Southcentral Utah. PhD dissertation, Department of Geosciences, University of Arizona, Tucson.

Weber, David J.

1969 Mexico and the Mountain Men, 1821-1828. Journal of the West 8:368-378.

1971 The Taos Trappers. University of Oklahoma Press, Norman.

Weide, David L.

1976 The Altithermal as an Archaeological "Non-Problem" in the Great Basin. In Holocene Environmental Change in the Great Basin. Edited by Robert Elston, pp. 174-185. Nevada Archaeological Survey Research Paper No. 6, Reno.

1978 Temper Analysis of Southern Nevada Prehistoric Ceramics: A Test Case of X-ray Diffraction. Western Anasazi Reports 1:177-184.

Weinberg, Julie B.

n.d. Growing Food in the High Desert Country, Publication PB13. Native Seeds/SEARCH, Tucson.

Wendland, Wayne M. and Reid A. Bryson

1974 Dating Climatic Episodes of the Holocene. Quaternary Research 4:9-24.

West, George A.

1925 Cliff Dwellings and Pueblos in the Grand Canyon, Arizona. Yearbook of the Public Museum of the City of Milwaukee, 1923, Vol. 3, pp. 74-96. Milwaukee.

1932 The Lost City of Nevada. Yearbook of the Public Museum of Milwaukee, 1930, Vol. 19, pp. 44-48. Milwaukee.

Westfall, Deborah A.
1985 Archaeological Test Excavations at the Energy Fuels Nuclear, Inc. Vermillion Cliffs Project, Kane County, Utah. Report submitted by Abajo Archaeology to the Bureau of Land Management, Cedar City District, Utah.

1986 Life in the Land of Little Water: The Prehistory of the Arizona Strip. Plateau 57(2):18-21.

1987a The Archaeological Survey of the Energy Fuels Nuclear, Inc. Pinenut Project Ore Haul Raod and Associated Gravel Quarries on the Kanab Plateau, Mohave County, Arizona. Report submitted by Abajo Archaeology to the Bureau of Land Management, Arizona Strip District Office, St. George, Utah.

1987b The Pinenut Site: Virgin Anasazi Archaeology on the Kanab Plateau of Northwestern Arizona. Bureau of Land Management, Arizona, Cultural Resource Series No. 4, Phoenix.

Wetherill, Ben W., and Elmer Smith
1934 Summary of Investigations by the Zion National Park Archeological Party. Zion and Bryce Nature Notes 6(1):1-9. Zion National Park.

Wheat, Carl I.
1957-1963 1540-1861: Mapping the TransMississippi West. 5 Volumes. Institute for Historical Geography, San Francisco.

Wheeler, George M.
1872 Preliminary Report Concerning Explorations and Surveys Principally in Nevada and Arizona, 1871. U.S. Government Printing Office, Washington, D.C.

1875 Preliminary Report Upon a Reconnaissance Through Southern and Southeastern Nevada, 1869. U.S. Army Engineering Department. U.S. Government Printing Office, Washington D.C.

1889 Report Upon United States Geographical Surveys West of the 100th Meridian. Geographical Report Vol. 1. U.S. Army Engineering Department. U.S. Government Printing Office, Washington, D.C.

Wheeler, S. M.
1942 Archaeology of Etna Cave, Lincoln County, Nevada. Mimeograph, Nevada State Park Commission, Carson City. (Reprinted 1973 in Desert Research Institute Publications in the Social Sciences No. 7, Reno.)

Whipple, A.W.
1856 Report of Explorations for a Railway Route, Near the 35th Parallel of North Latitude, from the Mississippi River to the Pacific Ocean. In U.S. War Department Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean, Made Under the Direction of the Secretary of War, in 1853-1856. Pacific Survey Reports Vol. III. A.O.P. Nicholson, Washington, D.C.

Whipple, Lt. A. W., Thomas Eubank, and William W. Turner

1856 Report Upon the Indian Tribes. In Report of Explorations for a Railway Route Near the Thirty-fifth Parallel of North Latitude from the Mississippi River to the Pacific Ocean, 1853-1854. Edited by Lt. A. W. Whipple and Lt. Joseph C. Ives. Pacific Survey Reports, Vol. 3, Senate Executive Document No. 78, 33rd Congress, 2nd Session, Washington, D.C.

Whitaker, Bob

1986 Arizona Strip Close Up. Arizona Highways 62(3):20-27.

Wiessner, Polly

1983 Style and Social Information in Kalahari San Projectile Points. American Antiquity 48:253-276.

Wilde, James D., editor

1986 Archaic Dates from NW Arizona Rockshelter. Of Human Interest: The Newsletter of BYU Anthropology and Archaeology 2(1):2.

Willey, Gordon R., and Phillip Phillips

1958 Method and Theory in American Archaeology. University of Chicago Press, Chicago.

Wilson, Allie Kathleen

1941 History of the Arizona Strip to 1913. Unpublished M.A. thesis, Arizona State Teacher's College, Flagstaff.

Wilson, Dean

1985 Analysis of Ceramics Recovered from the Vermillion Cliffs Project. In Archaeological Test Excavations at the Energy Fuels Nuclear, Inc. Vermillion Cliffs Project, Kane County, Utah, by Deborah A. Westfall, pp. 114-132. Report submitted by Abajo Archaeology to the Bureau of Land Management, Cedar City District, Utah.

Wilson, Iris Higbie

1965 William Wolfskill, 1798-1866: Frontier Trapper to California Ranchero. Arthur H. Clark, Glendale, California.

Wilson, John P.

1976 An Early Pueblo II Design Style. Awanyu 4(2):8-22.

Winterhalder, Bruce, and Eric A. Smith, editors

1981 Hunter-gatherer Foraging Strategies. University of Chicago Press, Chicago.

Winther, Oscar Osburn

1964 The Transportation Frontier: TransMississippi West, 1865-1890. Holt, Rinehart, and Wilson, New York.

Wobst, H. Martin

1974 Boundary Conditions for Paleolithic Social Systems. American Antiquity 39:147-178.

1977 Stylistic Behavior and Information Exchange. In For the Director: Essays in Honor of James B. Griffin, edited by C. A. Cleland. Museum of Anthropology, Anthropology Papers No. 61. University of Michigan, Ann Arbor.

Wood, Donald G.
1979 Reports of Cultural Resource Surveys Conducted in the North Kaibab Ranger District, Kaibab National Forest, Arizona. In Western Anasazi Reports 2:141-206.

Woodbury, Angus
1931 The Route of Jedediah S. Smith in 1826 from the Great Salt Lake to the Colorado River. Utah Historical Quarterly 4:34-46.

1944 History of Southern Utah National Parks. Utah Historical Quarterly 12:111-222.

Woodbury, Richard B.
1954 Prehistoric Stone Implements of Northeastern Arizona. Papers of the Peabody Museum of American Archaeology and Ethnology 34. Harvard University, Cambridge.

Wright, H. Diane
n.d. Stone Houses Just East of Cliff Dwellers Lodge. Ms. on file, Museum of Northern Arizona Library, Flagstaff.

Wright, Owen B.
1972 Background and History of the Arizona Strip District. Ms. on file, Arizona Strip District Office, St. George.

Wyckoff, Donald G.
1977 Secondary Forest Succession Following Abandonment of Mesa Verde. The Kiva 42(3-4):215-231.

Zier, Christian J., Jeffrey H. Altschul, Marcia K. Kelly, Martin R. Rose, Kurt P. Schweigert, and Kenneth R. Weber
1987 Historic Preservation Plan for Fort Carson Military Reservation, Colorado. Report submitted to the National Park Service, Rocky Mountain Regional Office, Branch of Interagency Archeological Services, Denver.

APPENDICES

APPENDIX 1

LOCATIONS OF COLLECTIONS, SOURCE DOCUMENTS AND FILES

This section lists the various institutions in North America which are known to have collections and primary source documents from the Arizona Strip. The institutions are listed in alphabetical order and the types of information and artifact collections curated at each are briefly summarized.

I. Arizona State Museum, Tucson

1. The ASM Archives houses the Gila Pueblo collection, which contains several manuscripts pertaining to Gila Pueblo's reconnaissances on the Arizona Strip and in the Grand Canyon National Park during the 1930's.
2. Computerized site information on all BLM Arizona Strip District sites and all sites recorded by WACC personnel in Grand Canyon National Park and Lake Mead National Recreation Area are included on AZSITE, a computer data file maintained by the Office of Contract Archaeology. Some sites recorded by the Museum of Northern Arizona and the Southwest Museum are not included on AZSITE.
3. Copies of recent (ca. 1982+) clearance reports for projects conducted on the BLM Arizona Strip District.

II. U.S.D.I. Bureau of Land Management, Arizona Strip District Office, St. George, Utah

1. Computerized site cards and locational data for most of the cultural resources recorded on BLM lands on the Arizona Strip. Sites are numbered by the Arizona quad system.
2. Clearance reports for in-house surveys conducted since 1982. (Prior surveys were cleared with form letters.)
3. Preliminary and final reports submitted by contracting institutions for work done on BLM lands.
4. A small library of major publications and manuscripts pertaining to the archaeology and history of the region.
5. Aerial photos, topographic maps and a variety of other maps pertaining to the soils and vegetation of the District.

III. U.S.D.A. Forest Service, Kaibab National Forest Supervisors Office, Williams, Arizona

1. Computerized site files and locational information for sites recorded on the North Kaibab Ranger District. Sites are numbered sequentially by Forest districts according to the USFS numbering system.
2. Photographs and grab sample collections for many of the sites on the District.
3. Prelimianary and final reports on research and contract surveys conducted on the District.
4. Aerial photos, topographic maps, and maps on soils and vegetation of the District.

IV. Lost City Museum, Overton, Nevada

1. There is a small collection of miscellaneous artifacts from the western portion of the Arizona Strip, most of which are poorly provenienced.

V. Milwaukee Public Museum, Wisconsin

1. Miscellaneous notes, photographs and collections from West's 1923 expedition to Grand Canyon National Park.
2. The S.A. Barrett Collection of Southern Paiute material culture.

VI. Museum of the American Indian, Heye Foundation, New York

1. A very small collection of site cards and miscellaneous collections from Mark Harrington's preliminary surveys on the western margin of the Arizona Strip.

VII. Museum of Northern Arizona, Flagstaff

1. An excellent working library of primary and secondary source materials pertaining to the archaeology, biology, geology, ethnology and history of Arizona. Of particular interest is the unpublished manuscript on the 1964-65 highway salvage excavations along Highway 395 betweeen Fredonia and Littlefield (Wade 1967), stored in the library vault.
2. Site information from all projects conducted by the Museum on the Arizona Strip since the 1930's. Sites are filed by NA number and cross-referenced by the ASM quad system. In addition to site survey cards and locational plots, many of the sites have associated grab samples. Field notes, maps and photographs are available for most of the sites. The judgmental grab collections from the Paria Plateau, Houserock Valley and Mount Trumball surveys, plus the excavated materials from Antelope Cave are particularly noteworthy.
3. Colton's original ceramic type collection from the AZ Strip.
4. Clearance reports for numerous small clearance surveys conducted by the Museum on the Arizona Strip.

VIII. U.S.D.I. National Park Service, Grand Canyon National Park

1. The Cultural Resource Division maintains site files and locational plots on 2000+ sites recorded within the park boundries.
2. Ceramic collections, whole pots and other artifacts recovered from the Park are curated in the Study Collection. (The only artifacts from the Park that are not curated in the Study Collection are the School of American Research survey and excavation collections. The SAR artifact collections are stored at The Western Archaeological and Conservation Center, Tucson.
3. There is a small working library containing final copies of research and contract reports on all projects conducted within the Park. as well as many of the major publications pertaining to the archaeology of the region. These reports are housed in the Cultural Resource office of the Cultural Management division.
4. The Study Collection has an extensive collection of primary and secondary source materials, as well as numerous photographs relating to the history of the Grand Canyon.

IX. U.S.D.I National Park Service, Western Archaeological and Conservation Center, Tucson

1. WACC curates artifact collections from the Lake Mead National Recreation Area, as well as other national parks in the Western region. The collections also include the materilas obtained by the School of American Researchdurin surveys and excavations and Unkar Delta, Walhalla Plateau, and other localities in the Grand Canyon.
2. Most of the original field notes from the CCC project excavations and subsequent work by Baldwin, Schroeder, and others in Lake Mead NRA are curated at WACC.
3. There is a working library containing numerous unpublished manuscripts, preliminary reports, and final reports on research and CRM projects conducted in Grand Canyon and Lake Mead NRC.

X. Nevada State Museum, Carson City

1. The Nevada State Museum has a small collection of site records from Lake Mead NRA, including copies of site cards from the Shivwits Plateau recorded by Baldwin in 1942 and Shutler in 1955-56.

XI. University of Nevada, Las Vegas

1. The Environmental Research Center has a few site records from the Arizona Strip, plus numerous records, collections and unpublished clearance reports from projects conducted in adjoining areas of Nevada.
2. The University Libtrary maintains a complete file of all unpublished Master's theses produced by students in the Department of Anthropology, several of which are pertinentr to the Anasazi prehistory of the Arizona Strip.

XII. Northern Arizona University, Flagstaff

1. Site files and artifact collections from the survey of State Highway 67 are maintained at the Archaeology Laboratory in the Bilby Research Center.
2. The NAU Special Collections Library has primary documents and photographs relating to the early history of Coconino and Mojave Counties, as well as numerous publications and journals relating to the history and archaeology of northern Arizona.

XIII. School of American Research, Santa Fe, New Mexico

1. Site cards and miscellaneous notes pertaining to SAR's work in Grand Canyon National Park.
2. The I.T. Kelly Collection of Southern Paiute material culture.

XIV. Smithsonian Institution, Washington, D.C.

1. A few site records, photographs and artifact collections from Judd's 1916-1920 reconnaissances on the Arizona Strip and adjoining portions of southern Utah are housed in the Anthropology Division.
2. John Wesley Powell's ethnographic notes and artifact collections relating to his work amoung the Southern Paiute on the Arizona Strip and southwestern Utah are also curated in the Anthropology Division (see Fowler and Fowler 1971; Fowler and Matley 1979).

XV. Southern Utah State College, Cedar City

1. The Archaeology Laboratory curates site records, notes, maps and collections from surveys and excavations directed by Richard H. Thompson in GRand Canyon National Park, the Kaibab Paiute Indian Resrervation and other miscellaneous locations on the Arizona Strip.
2. The SUSC Archaeology Laboratory has a curatorial agreement with the BLM Arizona Strip District Office to maintain notes and collections generated from projects conducted on BLM lands.
3. The Special Collections division of the SUSC Library contains the William R. Palmer Collection, Which includes documents, photos and artifacts relating to Palmer's ethnographic work amoung the Southern Paiutes at the turn of the century. The collection pertains primarily to the Paiutes of southwestern Utah.

XVI. University of Utah, Salt Lake city

1. The Museum of Natural History has very few archaeological collections from the Arizona Strip; however, it has extensive site records, maps, field notes, photographs and collections from surveys and excavations in Glen Canyon and adjoining areas of southern Utah.
2. The UU Library has an uncatalogued collection of manuscripts and notes donated by the late Juanita Brooks, some of which undoubtedly relate to the early history of the Arizona Strip.

APPENDIX 2

ARIZONA STRIP CODEBOOK

VARIABLE DESCRIPTION	COLUMN NOS.

Site No.

Last three parts of USFS or AZSITE site number, — 1-8
e.g. AR-03-07-04-650 = 07040650
e.g. AZ:A:1:4 = 0A010004
Repeat site number for each component

Institution — 9

Institution responsible for assigning site number:
1: MNA
2: ASM
3: BLM
4: Prescott College
5: USFS
6: NPS-Lake Mead
7: NPS-Grand Canyon

Components — 10-11

The first column of this variable indicates the number of components at the site. The second column indicates which components you are describing, e.g. if you have a site with three components and you are describing the first (earliest) you would code it as 31.
Each component is entered as a separate data line.

Site Type — 12-13

Habitation Site:
03: Non-contiguous rooms, no room count available
05: Mix of pueblo and non-contiguous structures, room count unknown*
06: Mix of pueblo and non-contiguous structures, 5 rooms or less*
07: Mix of pueblo and non-contiguous structures, 6-15 rooms total*
08: Mix of pueblo and non-contiguous structures, more than 15 rooms*
09: Pueblo/roomblock, no room count available
10: Habitation site, type unknown
11: Large structural site, more than 15 non-contiguous rooms*
12: Medium structural site, 6-15 non-contiguous rooms*
13: Small structural site, 2-5 non-contiguous rooms*
14: Large pueblo, more than 15 contiguous rooms
15: Medium pueblo, 6-15 contiguous rooms
16: Small pueblo, 2-5 contiguous rooms
17: Isolated structure (1 room)

* Includes pithouses

Site Type, continued

18: Base Camp

Base camps may be identified in one of two ways. The presence of a well-developed midden is automatically considered to be indicative of a base camp. However, well-developed middens are not likely to occur outside of sheltered situations. On open sites, base camps can be identified by the presence of at least three of the criteria listed below:

a) lithic debitage and/or sherds (50-100 flakes representing 3 different materials or more than 100 flakes or 50-100 sherds representing at least three different vessels or more than 100 sherds. At least 100 artifacts total.)

b) grinding implements (at least one mano, metate, bedrock mortar, etc.)

c) specialized flaked stone tools (other than bifaces, "knives", projectile points and utilized flakes; includes drills, scrapers, hammerstones, mauls, etc.)

d) one or more features (hearth, cist, roasting pit, etc. Concentrations of ashy or charcoal-stained soil can be counted as individual features. In rockshelters, smoke-blackening may be substituted for a hearth. Rock art may be counted as one feature regardless of the number of panels.)

Also, sites that contain at least 500 artifacts representing at least three lithic material types or ceramic types within an area 500 meters square or less, or which have an approximate density of 1 artifact per square meter in site over 500 meters square and which exhibit at least one other criterion of a base camp will also be designated as base camps.

19: Base or temporary camp (can not distinquish with AZSITE info)

20: Temporary Camps

A temporary camp exhibits at least two but less than three base camp criteria, e.g. a hearth and lithic debitage; sherds and lithics with a mano; a lithic scatter with specialized tools. Also, a site does not have to have the minimum number of artifacts specified in Criterion a) above as long as it has at least one other base camp criterion associated.
Note: Sites with granaries or cists are an exception. If the only things associated with a granary or cist are a few (ca. less than 100) artifacts, then the site should be classified as a limited activity site/isolated storage facility (see Code #38 below) rather than as a temporary camp.

VARIABLE DESCRIPTION **COLUMN NOS.**

Limited Activity Sites

30: Limited activity site, type unknown
31: Quarry/mine (lithic scatter associated with a raw material source).
32: Lithic scatter (debitage, cores, unfinished bifaces and projectile points. No source area associated. No features or specialized tools.)
33: Sherd scatter (sherds only. Includes pot drops. No features or specialized tools.
34: Sherd and lithic scatter (combination of 32 and 33).
35: Isolated roasting pit (s) (No other features or artifacts).
36: Isolated hearth (s) (No other features or artifacts).
37: Isolated rock art (No other features or artifacts).
38: Isolated granaries/cists (No other features).
39: Agricultural features/water control devices: terraces, check dams, waffle gardens, reservoirs, etc., not associated with habitations.
40: Trail/route/pecked steps.
41: Burial
49: Other limited activity site type (type known but not coded.)
99: Site type unknown (may or may not be habitation site; insufficient data.)

Temporal Affiliation 14-15

01: Paleoindian (Folsom, Clovis)
10: Archaic (Elko-eared)
11: Early Archaic (Pinto, Northern Side-Notched and Humbolt Concave Base (only those with parallel oblique flaking patterns should be called Humbolt. Otherwise they probably are McKean.))
13: MIddle Archaic (Sudden, Hawken and Rocker Side-Notched)
15: Late Archaic (San Rafael, McKean, Gypsum)
18: Late Archaic/BM II (San Pedro and San Juan style)
19: Aceramic Unknown (Elko Side- and Corner-Notched)
20: Pueblo/Anasazi (A.D. 500-1300)
21 BM III (A.D. 500-800) Plain gray pottery with or without Lino B/G.
22: BM III-P I (A.D.500-950?) Same as 21 with Washington B/G and Kana-a Gray(neckbanded) and Kana-a B/W (latter types rare).
23: Early P II (A.D. 950?-1050) Plain Gray Types (North Creek, Moapa, Shinarump) St. George B/G (Black Mesa-Sosi equivalent). Sparse red wares (Deadmans B/R, Medicine B/R). No corrugated. Parowan Basal-notched.
24: Early Anasazi BM III-PI/early PII (A.D.500-1050). Combination of 21, 22, and 23. No corrugated wares. Decorated wares less abundant than plain. Red wares rare.
25: Mid PII (A.D. 1000-1100) B/W types include St. George, North Creek B/W (Sosi style), Virgin B/W, Hurricane B/W. Also Black Mesa and Sosi Dogoszhi B/W. Middleton Red or B/R or Tusayan B/R (these are often mistakenly called Deadmans B/R). No polychromes. Some plain wares but also corrugated types (Shinarump, North Creek, Tusayan Corrugated.) No Meonkopi style (e.g. no Washington Corrugated). Parowan basal-notched and Bull Creek projectile points. Also Cottonwood Triangular.

26: Late PII (also called early PIII or PII-III transition, A.D. 1100-1150). Basically the same as 23 but with corrugated wares more abundant. Corrugated ceramics include Moenkopi-style. Predominantly Sosi-Dogoszhi style of decoration. Polychromes may be present in small quantities (Tusayan, Citadel, Cameron or Nankoweap Polychrome). No St. George or Black Mesa style B/W. No Flagstaff. Parowan basal-notched or Bull Creek projectile points.
27: Early PIII (A.D. 1150-1200) Same as 24 with Flagstaff B/W.
28: Late Anasazi (PII-early PIII) If you cannot distinguish between 23, 25, 26, 27, and 30 and there are corrugated and red ware ceramics present, use this code.
29: Late PIII (any site with Tusayan or Kayenta Polychromes or B/W
30: PII (ca. A.D. 950-1150) Combination of 23, 25, and 26. No Flagstaff B/W or Polychromes.
40: PIV-V Hopi? (A.D. 1300-1800) Only ceramics are Jeddito B/Y
50: Prehistoric Paiute Paiute Brownware, Desert Side-notched points. Jeddito B/Y may be present. No historic material.
51: Historic Paiute Same as 50, but with Historic materials
60: Historic Navajo (A.D. 1850-1950) Sweat houses, corrals, pinyon camps accompanied by good ethnohistoric documentation. Otherwise, code as 70 below
70: Historic Paiute/Navajo Can not distinguish between 51 and 60.
99: Unknown cultural-temporal affiliation

Degree of Shelter 16

0: open (blank = 0)
1: partial shelter (rockshelter, overhanging cliff face, etc.)**
2: complete shelter (cave)
9: indeterminate

Miscellaneous Coded Comments

01: Marietta has revised the temporal affiliation.
02: Marietta thinks it is probably Anasazi (site form says unknown).
03: Coded as a Virgin Anasazi on the site form.
04: Historic component also present.

10: Coded as one component (site form says there are two but they are using term spatially, not temporally
11: Coded as one component (site form says there are more than two).
12: This is an isolated find that has been given a site number.

15: Mechanical disturbance noted on site form.
16: UNV-LV Big Ben Project; collection taken.

20: Site located at cliffbase or in/on cliffface; degree of shelter unknown.
21: Site located adjacent to meadow.
22: Rockshelters noted in close proximity to site.

VARIABLE DESCRIPTION **COLUMN NOS.**

Miscellaneous Coded Comments continued

30: Storage units present.
31: Site is called a fieldhouse on site form.
32: Kiva present.

33: Possible pithouses present (based on presence of depressions, dense artifacts with no visible structures, or opinion stated by recorder).
34: Check dams associated with site.
35: Marietta has determined a function different from that on site form.

37: Burial (s) present.
38: Rockart associated with site
39: Trail associated with site
40: Floral remains mentioned on site form.
41: Faunal remains mentioned on site form.
42: Roasting pits associated with site.

** see also Coded Comments #20 and 22

APPENDIX 3

COMPUTER PROGRAMS DEVELOPED FOR MERGING AND MANIPULATING DATA ON THE ARIZONA STRIP

by Daniel D. Mareno

The analysis was conducted through a combined use of Dames & Moore's Geographic Information Management System and a set of computer programs specifically developed for this project.

GIMS is a set of computer routines used to enter, manage and display spatially disposed data. GIMS has the facility to accept data in a variety of formats, including the formats established for AZSITE and the USFS data base.

The specially developed programs include the following:

PROGRAM NAME	DESCRIPTION
SUMMARY	READS THE CODESHEET FILE, CHECKS CONSISTENCY IN COMPONENT COUNTS, AND SUMMARIZES THE SITES BY VARIABLE.
SUMMARY1	READS THE CODESHEET FILE AND SUMMARIZES NUMBER OF SITES BY VARIABLE. NO ERROR CHECKING PERFROMED.
AZSITE	CONVERTS THE AZSITE RECORDS INTO A GIMS-1 POINT STRUCTURE FORMAT. USED FOR PLOTTING ONLY.
USFS	CONVERTS THE USFS SITE RECORDS INTO A GIMS-1 POINT STRUCTURE FORMAT. USED FOR PLOTTING ONLY.
REPORT1	READS THE AZSITE AND USFS FILES, AND REPORTS THOSE SITES LOCATED OFF ARIZONA STRIP DISTRICT.
BLMCODE	CHANGES THE FORMAT OF THE AZSITE FILE SO THAT SITE ID'S ARE IN A FIXED FORMAT. CREATES A NEW AZSITE FILE IN FIXED FORMAT TO FACILITATE SITE ID MATCHING PERFORMED IN THE MERGE PROGRAM.
MERGE	READS THE CODESHEET FILE, AND MATCHES THE SITE ID WITH SITES READ FROM THE AZSITE AND USFS FILES. ADDS THE SITE UTM X, Y COORDINATES TO A NEW CODESHEET FILE. USED FOR DEVELOPING GRID CELL FILES OF SITE CHARACTERISTICS.
CODETOG1	USER SELECTS VARIABLE FROM THE CODESHEET FILE. PROGRAM EXTRACTS THAT VARIABLE VALUE FROM FILE, X, AND Y, AND CONVERTS INTO GIMS-1 FORMAT FOR PLOTTING.

PROGRAM NAME	DESCRIPTION
SUMMARY5	READS AZSITE MANAGEMENT DATA FILE AND TABULATES SITES BY NATIONAL REGISTER STATUS, STATE REGISTER STATUS, SITE CONDITION, SOURCE OF DISTURBANCE, COLLECTIONS, AND ARCHAEOLOGICAL INVESTIGATION STATUS.

*U.S. GOVERNMENT PRINTING OFFICE: 1989-0-673-212/3028